GE
Measurement & Control

# RSDetection

## User's Manual

Applicable to part numbers:

RS-S131-200-ER0000
RS-S131-200-ERB000

S131-200-UM
Revision: NC
July 2013

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Twinsburg, OH 44087

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## REVISION HISTORY

| Revision | Revision History | Date |
|---|---|---|
| NC | Initial Release | 2013 July |
| | | |
| | | |

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## WARNINGS AND CAUTIONS

Throughout this manual, when necessary, notes are used to identify considerations.

**Definitions:**

**WARNING**: IDENTIFIES INFORMATION ABOUT PRACTICES OR CIRCUMSTANCES THAT CAN CAUSE AN EXPLOSION IN A HAZARDOUS ENVIRONMENT, WHICH MAY LEAD TO PERSONAL INJURY OR DEATH, PROPERTY DAMAGE, OR ECONOMIC LOSS.

**CAUTION**: IDENTIFIES INFORMATION ABOUT PRACTICES OR CIRCUMSTANCES THAT CAN LEAD TO PERSONAL INJURY OR DEATH, PROPERTY DAMAGE, OR ECON0MIC LOSS. CAUTIONS HELP YOU IDENTIFY A HAZARD, AVOID A HAZARD, AND RECOGNIZE THE CONSEQUENCES.

**SHOCK HAZARD**: LABELS MAY BE ON OR INSIDE THE EQUIPMENT TO ALERT THAT DANGEROUS VOLTAGE MAY BE PRESENT.

**NOTE**: IDENTIFIES INFORMATION THAT IS CRITICAL FOR SUCCESSFUL APPLICATION AND UNDERSTANDING OF THE PRODUCT.

### Product Warnings and Cautions:

THE SENSOR ENCLOSURE SHOULD BE OPENED ONLY BY TECHNICIANS TRAINED AND APPROVED BY GE REUTER-STOKES.

ALL SCREWS AND CONNECTORS MUST BE APPLIED TO RIGOROUS TORQUE SPECIFICATIONS TO CONFORM TO IP RATING AND ENSURE THE UNIT IS PROPERLY PROTECTED AGAINST ENVIRONMENTAL HAZARDS.

THIS INSTRUMENT DOES NOT INCLUDE PROTECTIVE GROUNDING WIRES. DUE TO THE FACT THAT THIS INSTRUMENT IS BATTERY OPERATED, AND MAY BE MOVED FROM LOCATION TO LOCATION, IT IS THE RESPONSIBILITY OF THE USER TO PROVIDE APPROPRIATE GROUNDING OF THIS DEVICE WHEN LOCATED IN AN AREA WHERE THIS MAY BE REQUIRED. CONSULT LOCAL ELECTRICAL CODES AND NORMATIVE REGULATIONS FOR APPROPRIATE GROUNDING REQUIREMENTS.

THE SENSOR HOUSING CONTAINS A PRESSURIZED IONIZATION CHAMBER WITH HIGH INTERNAL PRESSURE AND HIGH VOLTAGE (~400 VDC) ON ITS SURFACE WHEN POWER IS APPLIED. REMOVAL OF CHAMBER FROM ITS PROTECTIVE HOUSING OR MISHANDLING COULD CAUSE SERIOUS INJURY.

THIS ENCLOSURE MAY CONTAIN ONE LITHIUM-ION BATTERY. THIS ENCLOSURE CONTAINS A PRESSURE VESSEL MEETING THE REQUIREMENTS OF 97/23/EC.

WHEN SERVICING THE UNIT BY QUALIFIED, APPROVED PERSONNEL, ENSURE THAT POWER IS OFF BEFORE OPENING THE CASE. FAILURE TO DO SO WILL RESULT IN -400V APPLIED TO THE OUTSIDE OF THE CHAMBER AND MAY RESULT IN SHOCK. MISHANDLING MAY BURST THE CHAMBER AND RESULT IN INJURY OR DEATH.

THE RSDETECTION MAY ONLY BE OPENED BY TECHNICIANS TRAINED AND AUTHORIZED BY REUTER-STOKES.

TO PREVENT DAMAGE TO THE INTERNAL BATTERY AND INTERNAL CIRCUITS, DO NOT CONNECT A SOLAR PANEL AND BATTERY CHARGER SIMULTANEOUSLY.

THE (OPTIONAL) INTERNAL BATTERY USED IN THIS INSTRUMENT IS A LI-ION BATTERY AND SHALL ONLY BE REPLACED WITH AN INSPIRED ENERGY NH2057GE29 BATTERY. THIS IS AVAILABLE EITHER FROM GE REUTER-STOKES OR DIRECTLY FROM INSPIRED ENERGY. USE OF ANY OTHER BATTERY MAY CAUSE DAMAGE TO THE CHARGING UNIT OR THE INSTRUMENT.

THE CUSTOMER MUST PROVIDE EXTERNAL DC VOLTAGE FROM A SOURCE THAT IS CERTIFIED FOR OUTDOOR USE.

THE SENSOR IS CERTIFIED TO IP66.

THE SENSOR HAS OBTAINED US AND CANADIAN ETL CERTIFICATION.

THE SENSOR IS CERTIFIED TO CE.

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## BATTERY DISPOSAL INSTRUCTIONS

This product may contain one lithium-ion battery. In accordance with the European Directive 2006/66/EC, batteries and accumulators are marked with the crossed out wheeled bin, which indicates that they cannot be disposed of as unsorted municipal waste in the European Union.

The marking may also include a chemical symbol indicating that the battery contains substances classified as hazardous by the European Commission. Users of batteries must use the collection framework available to customers for the return, recycling, and treatment of batteries. Customer participation is important to minimize the negative effects of batteries to the environment and sustain available natural resources. For more information see www.weeerohsinfo.com.

To replace the battery refer to Optional Battery Replacement elsewhere in this document.

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# 1 INTRODUCTION

The RSDetection is the latest in the GE Reuter-Stokes line of Gamma Radiation Monitors. It measures gamma radiation dose rates up to 100 R/h (1 SV/hr) and supports a wide range of communication interfaces. This manual applies to all versions of the RSDetection, whose part numbers are RS-S131-200-ERxxxx. Configurations include:

- RS-S131-200-ER0000 Gamma Radiation Monitor with no battery
- RS-S131-200-ERB000 Gamma Radiation Monitor with battery

All references to RSDetection in this manual apply to all part numbers above unless otherwise specified.

## 1.1 HARDWARE OVERVIEW

The RSDetection is a self-contained gamma monitor which consists of three major components.

### 1.1.1 High-Pressure Ion Chamber

The high-pressure ion chamber (HPIC) is a highly sensitive and stable detector for gamma radiation. Gamma rays enter the argon gas, ionizing the gas and generating current.

### 1.1.2 Electrometer

The electrometer converts the ion chamber current to a value that can be read by the DAQ board. The electrometer mounts directly to the ion chamber. It connects to the DAQ board by a cable that supplies power to the electrometer and provides a communication interface.

### 1.1.3 DAQ Board

The DAQ board gathers data from several internal inputs and supported external sensors. A processor is used to gather sensor data and perform calculations. The data is stored in a database for later retrieval.

The application firmware is stored in flash memory. It can be updated over the Ethernet using any FTP application or via the supplied configuration utility. This allows new features and program updates to be installed without returning the product to the factory.

The DAQ board hosts an industrial grade SD card that contains the operating system, the application and the database. This card is required to run the unit and should not be removed.

The DAQ board implements a number of external connections:

- Ethernet
- Dedicated RS-232 serial
- USBB connection that mounts as a serial port on the host computer
- USBA to serial converters that communicate via RS-232 (maximum of 2 supported)

Users can request data and configure the system through these ports. These connections are standard on all units.

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## 1.2 Firmware Overview and Operational Concepts

### 1.2.1 Windows CE

The firmware operates under the Windows CE (Windows Embedded Compact) operating system. This system was developed by Microsoft and intended for embedded devices typically running from flash memory. Details on Windows CE and related technologies are available on the Microsoft website.

### 1.2.2 Configurations

The unit behavior is driven by configurations that are associated with events and measurements, as well as miscellaneous features such as serial ports, system operation, and various other system entities. The configuration utility provides customization of all the configurable parameters. A complete list is provided in the Configurations Tab section in this manual.

### 1.2.3 Events

Events are data entities that are associated with sensors and have a fixed number of states. For example, external power can be off or on, or a measurement can be above or below its alarm limit. When an event changes state, there are two actions that may take place depending on the configuration for that event:

#### 1.2.3.1 Log to the Event Log

The prior and current states are recorded along with date/time and optional comments concerning the event.

#### 1.2.3.2 Notification

The unit can be configured to send the event state when the state changes. The actual output is an XML event command containing the same properties that are logged. See the Notifications section of this manual for further details.

### 1.2.4 Scalar Measurements

Actual data values are represented by measurements. Most measurements fall into the category of Scalar Measurements. A scalar is expressed as a numerical value. Each measurement has a unit type, such as volts or dose rate, and formatting information defined by its associated configuration. See the Software Configuration Utility section of this manual for complete descriptions.

### 1.2.5 Composite Measurements

There are some measurements whose data does not fit into a numerical quantity. Currently there are two measurements in this category, the battery charger data and the optional meteorological sensor. In these cases, a block of data is provided by the device.

There are scalar measurements which are derived from the composite data. For example, the scalar measurement BatteryCurrent is taken from the composite measurement. A consequence of deriving scalars from the composite is that the sampling interval of battery current cannot be independently configured, since it is tied to the update interval.

### 1.2.6 Legacy Commands

These commands support a simple ASCII command set that is compatible with prior generations of gamma monitoring products. Although most are supported, some are not due to architectural differences. These commands are only supported on serial communication channels via direct RS-232 or a USB connection (not supported on Ethernet). A list of the supported and unsupported commands is described in the Appendix.

### 1.2.7 XML Commands

XML commands are new to the RSDetection unit and support all of the configurable capability, measurements, and events. These commands and responses conform to the XML standard widely used in internet data transfer. All of these make use of XML elements, which typically have a start-tag and an end-tag with the content between them.

A description of these commands, which is beyond the scope of the user manual, is located in a separate manual titled RSDetection Communication Manual, S131-200-COMM.

### 1.2.8 Notifications

Most of the communication between a connected computer and the RSDetection unit can be accomplished by sending commands and receiving responses. Notifications can be used to send information from the unit to the computer without a command. In the case of events, these are generally sent when there is a change of state. For measurements a notification is sent when a new sample is made, even if the value does not change as a result of the update.

The three levels of control for sending notifications are described below.

- RSDetection Level - In the RSDetection system configuration a NotifyEnable property is available. If false then no notifications are sent even for those individual notifications that are enabled.
- Measurement/Event Configuration - Each event and measurement has its own notification enable that inhibits or allows notifications for that one item.
- Communication Channel - When a host computer establishes a connection (Ethernet or serial), notifications are disabled by default. In order to start notifications, a NotifyEnable command must be sent with the enable property set to **true**. Reference the RSDetection Communication Manual for details of this command.

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### 1.2.9 Database

Data is stored in a SQL CE database designed for use with the Windows CE operating system. The database consists of four tables.

- Configuration
- Events
- ScalarMeasurement
- CompositeMeasurement

A block diagram of these tables is in Figure 1.

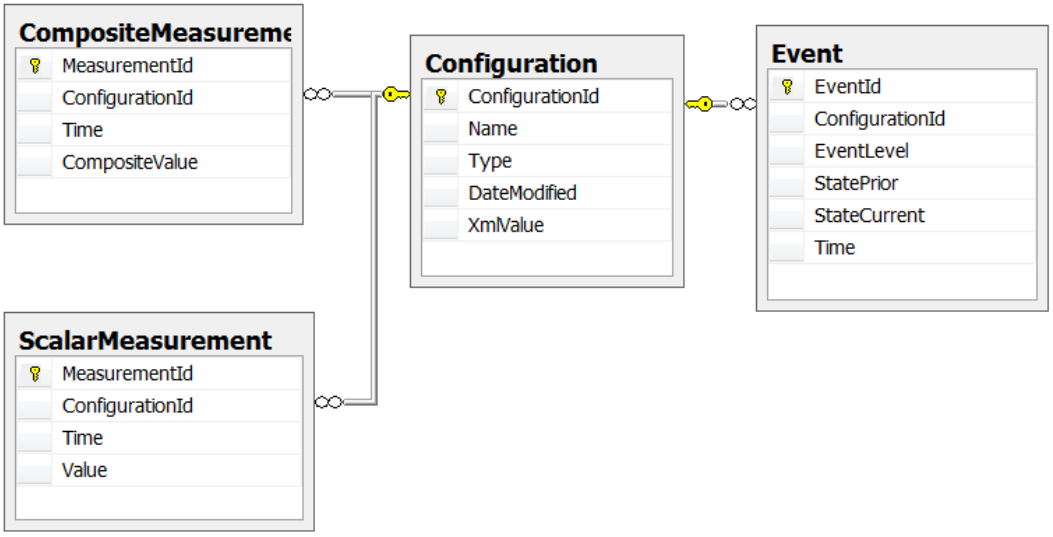


Figure 1 Database Tables

Each sensor, if enabled, will record data to this database. Data for each sensor is recorded based on the customer-specified logging interval. All data is an average value calculated over the logging interval.

Sensors can be sampled every 5 seconds, but may be sampled less frequently if desired. The electrometer is the lone exception. It is always sampled every 5 seconds and cannot be changed.

For example, a sensor may be configured to log a sensor every 5 minutes and read the sensor every 10 seconds. In this case, the database records the average value of 30 samples taken once every 10 seconds for 5 minutes.

In addition to sensors, events are also recorded to the database.

#### 1.2.9.1 Database Size

The database is limited to a maximum of 3 million records. Once the database has been filled, the oldest records are deleted to allow new data to be recorded. Typical recording intervals will result in over one year of recorded data.

THE DATABASE MAY BE CUSTOMIZED USING THE CONFIGURATION UTILITY TO MEET CUSTOMER NEEDS.

### 1.2.10 Time and Time Zones

Since the RSDetection operates on Windows CE, it is time zone aware and is always configured to maintain the date and time based upon Greenwich Mean Time (GMT). When XML commands are received that include date and times, the unit expects to receive the time with the proper time zone offset.

## 1.3 COMMUNICATIONS

The RSDetection unit fundamentally has 2 types of communication options - serial point to point and network.

Figure 2 shows a picture of the communication connections and is followed by a description of each.

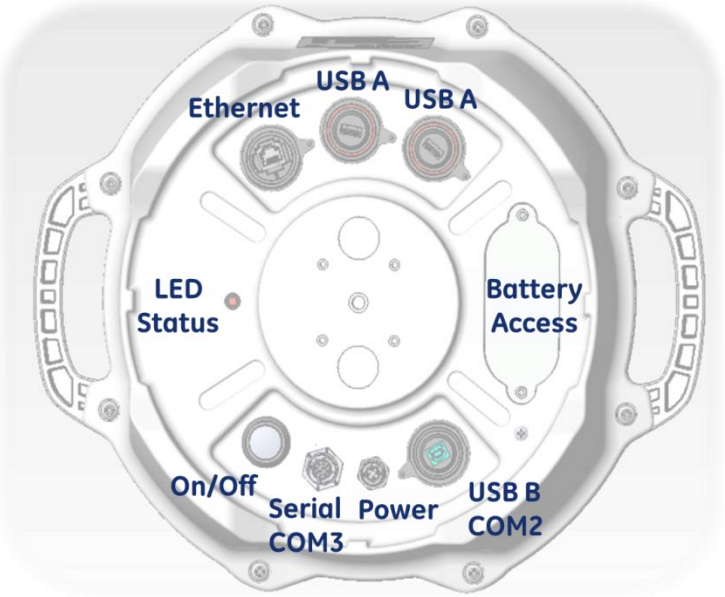


Figure 2 Communication Connections

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### 1.3.1 Serial COM3

- Dedicated RS-232

  A 10-pin circular connector contains a dedicated serial port. This port is always present and is identified as COM3 in the unit and in the configuration utility. The default configuration for this port is 9600 BAUD, 8 bits, No Parity, and no handshaking.

  If this port is not used, the cap that ships with the unit must be placed over the connector to provide protection from humidity and precipitation.

  The optional cable, part number RS-S131-200-232, is used to communicate to a standard DB-9 device, such as a PC. This cable has a weatherproof connector on one end, but the other end is not weatherproof. The customer must weatherproof this connector via a NEMA box or other enclosure.

  For customer systems that were wired for the RS-S131 units, a serial adapter cable can be purchased to transition from the 10-pin connector to the older connectors used on the RS-S131. The part number is RS-S131-200-232-AD.

- USB-B Direct to a PC

  The USBB connector is square. The USBA connector is rectangular. This USB connection is designed for direct connection with the PC using a standard USBB to USBA cable. Similar to the dedicated RS-232 port, it is always present and has the device name of COM2.

  The unit ships with an RS-S131-200-USBB cable. This cable has a weatherproof connector on one end, but the other end is not weatherproof. The customer must weatherproof this connector via a NEMA box or other enclosure.

  When the USB cable is plugged into a PC the PC will recognize the unit as a serial port and create a virtual serial port in the PC. The name of this port will vary depending on the PC, so it is important to know which port was added as a result of connecting the unit.

  Once the port name is known, the port can be opened and commands can be sent to the unit. This connection serves as a convenient alternative connection for configuration and data collection since it does not require a router or network. The default configuration for this port is 460800 Baud, 8 bits, No Parity, and no handshaking.

- USB-A to Serial Converter

  Additional COM ports can be added using USB-to-serial adaptors which contain an FTDI chip (USB232R-xx). The converters are plugged into the rectangular USBA connectors.

  A weatherproof cable is not shipped with the unit for these ports. A USBA cable can be purchased (part number RS-S131-232-USBA). This cable has a weatherproof connector on one end, but the other end is not weatherproof. The customer must weatherproof this connector via a NEMA box or other enclosure.

  Once the device is connected, the RSDetection creates a serial port, and the port can then be configured via the configuration utility. The first device that is plugged in will be assigned the name COM1 and the second COM4. Use these device names when configuring the ports using the utility.

  The default configuration for these ports is 19200 BAUD, 8 bits, No Parity, and no handshaking.

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### 1.3.2 TCP/IP

A network connection is available on the RJ-45 connector. Although a standard networked cable can be connected, this method is not weatherproof and should only be used for testing and configuration in a lab environment.

The unit ships with an RS-S131-200-EN Ethernet cable. This cable has a weatherproof connector on one end, but the other end is not weatherproof. The customer must weatherproof this connector via a NEMA box or other enclosure.

As with any network-capable device the unit must have an IP address assigned by a DHCP server or configured with a static IP address. For details on configuration see the RSDetector configuration entry on the Configuration screen and consult with your IT department for the appropriate configuration.

The LED located on the unit base indicates the current operational status as described in Table 1.

## 2 LITHIUM-ION BATTERY

ONLY USE THE BATTERY PROVIDED WITH THE UNIT TO ENSURE PRODUCT SAFETY. IF THE BATTERY SHOULD REQUIRE REPLACEMENT, ONLY USE GE P/N RS-S131-200-BATT.

THE BATTERY AND BATTERY CHARGER HAVE MULTIPLE LEVELS OF SAFETY INCORPORATED IN THE DESIGN, BUT THE FOLLOWING CAUTIONS SHOULD ALWAYS BE OBSERVED:

Handling

- Avoid shorting the battery
- Do not immerse in water
- Do not disassemble or deform the battery
- Do not expose to or dispose of the battery in fire
- Avoid excessive physical shock or vibration
- If the battery has visual physical damage, do not use
- Keep out of reach of children
- Never use a battery that appears to have suffered abuse

Charge and Discharge

- Charge with an appropriate charger only
- Never use a modified or damaged unit to charge the battery
- Use unit only as specified

Storage

- Store in a cool, dry, and well-ventilated area

Disposal

- Dispose of in accordance with local regulations

THE OPERATING TEMPERATURE OF THE BATTERY IS -10C TO +55C. OPERATION OF THE RSDETECTION UNIT OUTSIDE THE OPERATING TEMPERATURE MAY RESULT IN REDUCED PERFORMANCE.

The lithium-ion battery does not require an external battery charger. The battery is charged when external power is applied and the internal temperature of the battery is between 5C and 44C. The battery automatically powers the unit when the external power is removed.

In the absence of external power, the battery should operate the RSDetection for approximately 48 hours if fully charged. Refer to the datasheet for specification.

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# 3 FIELD INSTALLATION

THIS SECTION ASSUMES THE RSDETECTION HAS PREVIOUSLY BEEN CONFIGURED FOR DEPLOYMENT AND TESTED BEFORE TAKING IT TO THE INSTALLATION SITE AND THAT IT WILL BE MOUNTED WITH THE CABLE CONNECTORS FACING DOWNWARD.

It is the customer's responsibility to provide the hardware and utility connections required for installation, including all mounting hardware, support structures, and external power at the installation site. All electrical items must be either certified for outdoor use or enclosed in an appropriate NEMA enclosure. Items needed for basic installation are:

- An external 12V DC power supply to operate the unit and charge internal battery if so equipped.
- An Ethernet interface, such as a router, if Ethernet communications will be used.
- A mounting structure, such as a post with mounting flange, another case to enclose the unit, or other design of the customer's choosing.
- #10"-24 machine-threaded screws or bolts for mounting hardware. The RSDetection mount is identical to that used on the RS-S131 and is compatible with tripod-type mounting systems.

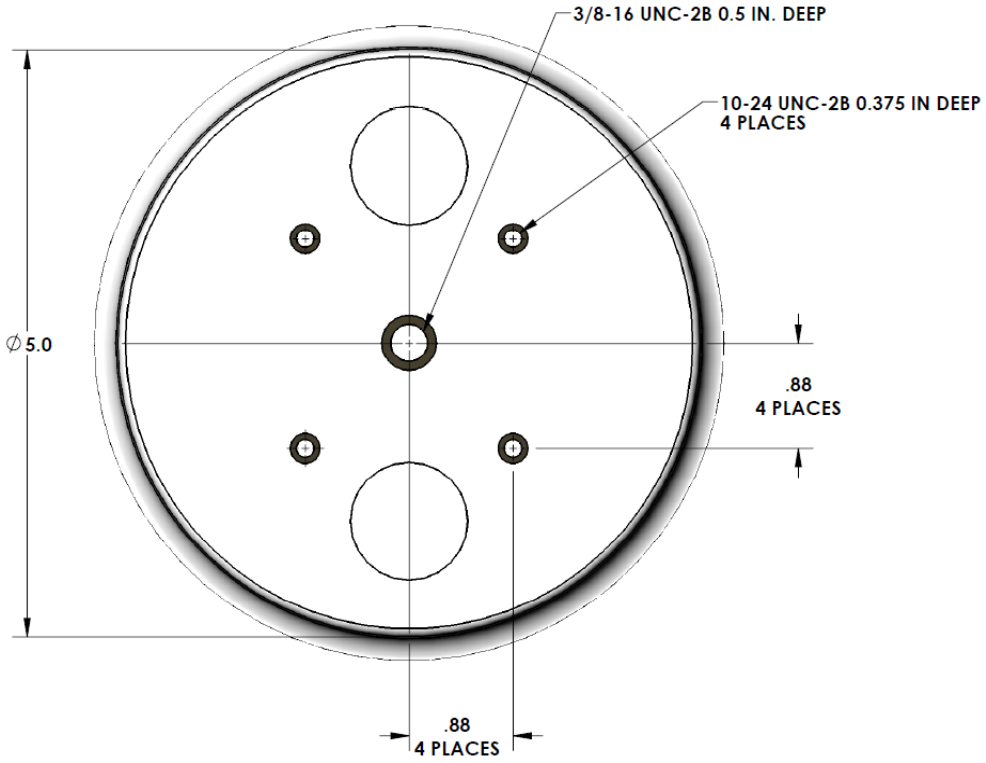


Figure 3 Mounting Flange Dimensions (inches)

USE APPROPRIATE LIFTING AND HANDLING TECHNIQUES WHEN INSTALLING THE UNIT.

IT IS THE CUSTOMER'S RESPONSIBILITY TO ENSURE THAT ALL ELECTRICAL CONNECTIONS (POWER, COMMUNICATIONS EQUIPMENT, ETC.) ARE EITHER OUTDOOR CERTIFIED OR APPROPRIATELY HOUSED IN NEMA ENCLOSURES.

The recommended installation steps are as follows:

1. Ensure the RSDetection is powered off.
2. Mount the RSDetection on the support structure using customer-provided hardware.
3. Connect desired communication cables (RS-232, Ethernet, USB). Available cables are listed in Table 20.

CONNECT THE RSDETECTION UNIT TO THE PC BEFORE STARTING THE CONFIG UTILITY IF USING THE USBB CONNECTION OR USB TO RS 232 ADAPTOR ON THE PC.

4. Connect external power cable. The RSDetection power wiring is shown in Table 18.
5. Apply power to the unit.
6. Verify the following LED sequence occurs:
   - Off for approximately 5 seconds
   - Solid red
   - Solid yellow
   - Blinking green
7. Monitor data until the unit is operating properly. This can be done using the Configuration Utility windows (the Measurements or Plots tabs are recommended).

## 3.1 CONFIGURATION UTILITY

Installation of the Configuration Utility on the system computer is required prior to operation of the RSDetection unit. Reference the Configuration Utility Installation section in the Appendix.

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## 3.2 FIRMWARE

Firmware for the RSDetection is already installed on the unit when it is shipped. The unit can be reprogrammed using any FTP application or through the Configuration Utility. Note that a network connection is required for updating the firmware or OS, a serial connection cannot be used.

A single, multi-color LED indicates the current operational status as shown in **Error! Reference ource not found.**. If multiple conditions exist, the LED may alternate between states. For example, it may blink alternating between green and yellow to indicate it is operational but no Ethernet connection exists between the RSDetection and host computer.

The following steps outline the procedure for downloading new versions of the firmware:

XX.XX.XX IS THE VERSION. VERSION MAY BE A DIFFERENT FORMAT.

1. Install the "Software/Manual CD" part number RS-S131-200-CD into the computer.
2. Browse the CD and locate the firmware version from the folder \RSDetection_Ver_XX.XX.XX.
3. Browse the CD and locate the Operating System version from the folder \CoreLoad_Ver_XX.XX.XX.

### 3.2.1 Determine Required Updates:

If the new version of firmware is greater than the current version, updating the "RSDetection.cab" file is required.

If the new version of the Operating System is greater than the current version, updating the "CoreLoad.cab" file is required.

### 3.2.2 Downloading and Installing Firmware:

1. Run the Configuration Utility.
2. If the CoreLoad.cab file requires updating, select **Upload Unit Firmware** from the File menu and browse to the CD folder (or the folder that the files were copied to).
3. Select CoreLoad.cab from the CD path \CoreLoad_Ver_XX.XX.XX\CoreLoad.cab. A progress bar displays. The file may take several minutes to download.
4. After the file downloads into the unit, a notification message displays.

### 3.2.3 Updating the RSDetection.cab file

1. Select **Upload Unit Firmware** from the File menu and browse the CD folder (or the folder that the files were copied to).
2. Select CoreLoad.cab from the CD path \RSDetection_Ver_XX.XX.XX\ RSDetection.cab. A progress bar displays.
3. After the file is downloaded into the unit, a notification message displays.

After the files download, turn the power off and then back on. The unit's LED blinks normally after the new firmware installation is complete. If CoreLoad.cab was updated, installation may take several minutes.

THE RSDETECTION UNIT MUST REMAIN POWERED UP DURING THE DOWNLOAD AND INSTALLATION PROCESS. IF POWER IS LOST DURING THE PROCESS, THE UNIT MAY NEED TO BE RETURNED FOR FIRMWARE INSTALLATION.

Table 1 LED Operations

| LED Light | Phase |
|---|---|
| Solid red | Start-up phase 1 |
| Solid yellow | Start-up phase 2 |
| Double blinking green | Unit operating properly on external power and connected to network |
| Single blinking green | Unit operating properly on battery and connected to network |
| Alternating double green and single yellow | Unit operating properly on external power and not connected to network |
| Alternating single green and single yellow | Unit operating properly on battery and not connected to network |

## 3.3 Maintenance and Service

The RSDetection requires limited maintenance. Only periodic calibration of the unit and replacement of the optional battery is necessary. In both cases, the unit should be removed from its customer-provided mounting hardware prior to servicing.

USE APPROPRIATE LIFTING AND HANDLING TECHNIQUES WHEN INSTALLING THE UNIT.

### 3.3.1 Calibration

It is recommended the RSDetection is calibrated on a periodic cycle. Reuter-Stokes recommends calibration cycles determined by the customer's quality program. A description of the calibration method used is detailed in the Calibration section of this manual.

### 3.3.2 Optional Battery Replacement

The percent remaining battery capacity may be useful in determining the battery replacement interval. The Percentage Battery Capacity can be found by referencing the PercentBatteryCapacity measurement parameter in the Configuration Utility.

A BATTERY WITH A FULL CHARGE CAPACITY OF 11.60AH (NEW) WILL PROVIDE A NOMINAL 48 HOUR RUN-TIME UNDER NORMAL UNIT OPERATION.

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IT IS RECOMMENDED THAT THE BATTERY IS REPLACED WHEN THE REMAINING BATTERY CAPACITY FALLS BELOW CUSTOMER REQUIREMENTS OR 5 YEARS, WHICHEVER COMES FIRST.

Follow these steps to remove and replace the battery:

1. Loosen the battery cover screws (Figure 4) using the 9/64" socket or driver. These are captive and cannot be separated from the cover.

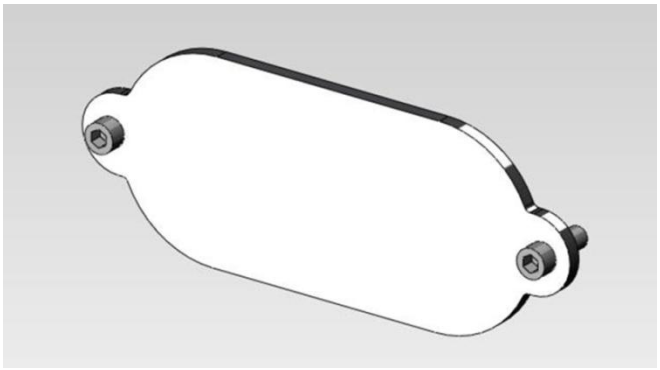

Figure 4 Battery Cover

2. Lift the cover off the case.
3. Remove the battery cover gasket.

4. Remove the connector from the battery (Figure 5).

Figure 5 Battery Connector

5. Lift the battery out of the case.
6. Place a new battery in the case. The battery should be oriented so that the connector is located toward the outside edge of the case. This allows the battery cable to be connected without undue strain.
7. Insert connector onto the battery.
8. Place the gasket back onto the case.
9. Place the battery cover over the gasket.
10. Secure the battery cover by tightening the captive screws. For proper weatherproofing, these must be torqued to 30 inch-pounds using an appropriate torque wrench.

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# 4 OPERATION

## 4.1 HPIC PRINCIPLES OF OPERATION

The HPIC was designed with the objective of achieving the best balance between sensitivity, energy response, stability, measurement range, and accuracy. No one technology has the optimal characteristics for each of these specifications, but the HPIC was selected because it was the best overall solution. The detector consists of a 10-inch stainless steel outer sphere that contains approximately 25 atmospheres of argon. Figure 6 illustrates the basic detector, with outer 10-inch cathode and inner 2-inch anode.

In operation, a high-voltage bias of -400 volts is applied to the outer shell, while keeping the anode at ground potential. When gamma photons pass through the detector they interact with the steel wall and the argon gas to generate ionized argon gas molecules. The amount of ionization produced is primarily a function of the number of photons, the gamma ray energy, and the incident direction of the photons.

In practice it is assumed that the directional effects average out and that the energy and flux are the most important. The ionization produced will be swept to the anode and cathode by the electric field within the detector; this generates an electric current that is a function of the incident flux and photon energy.

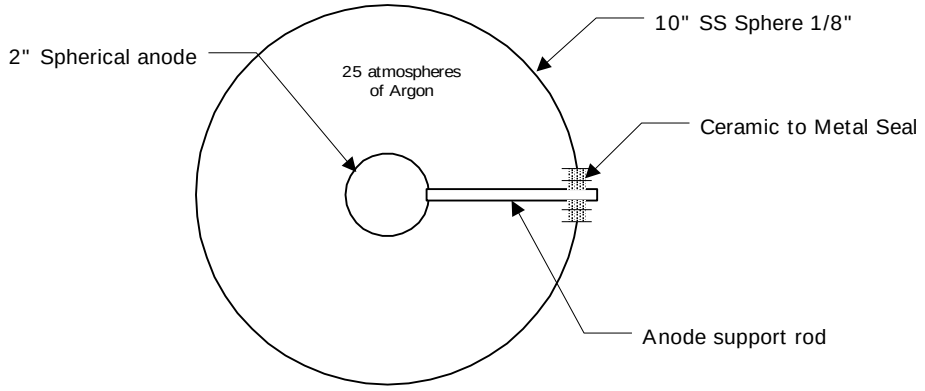


Figure 6 HPIC Diagram

The effect of energy on the output is important since the desired relationship is for the energy response to be "air like." This means the response of the detector will be proportional to the ionization produced in air. The actual energy response is described in the next section.

The range of the detector is also an important factor. To guarantee a linear output with gamma intensity it is necessary to collect all the ions generated before they recombine and therefore are not measured. To ensure this occurs the bias voltage must be high enough to collect all of the ions. This condition is called saturation. The higher the gamma field, the higher the voltage required to achieve saturation.

There are other characteristics that are important such as accuracy, stability, directional response, and others which are not covered in this section. These parameters are functions of the entire system including electrometer, analog signal conditioning, etc., and therefore are covered in the system specifications.

### 4.1.1 Energy Response

Energy response is the signal measured as a function of the gamma ray photon energy. Ideally this response should be flat, such that no energy generates more ions than it would in air. The response is characterized by a curve whose X-axis is energy and whose Y-axis is the normalized energy response. The normalization of the response means that the nominal response for any energy would be 1.0 if the detector were ideal. For the HPIC the response curve is shown in Figure 7.

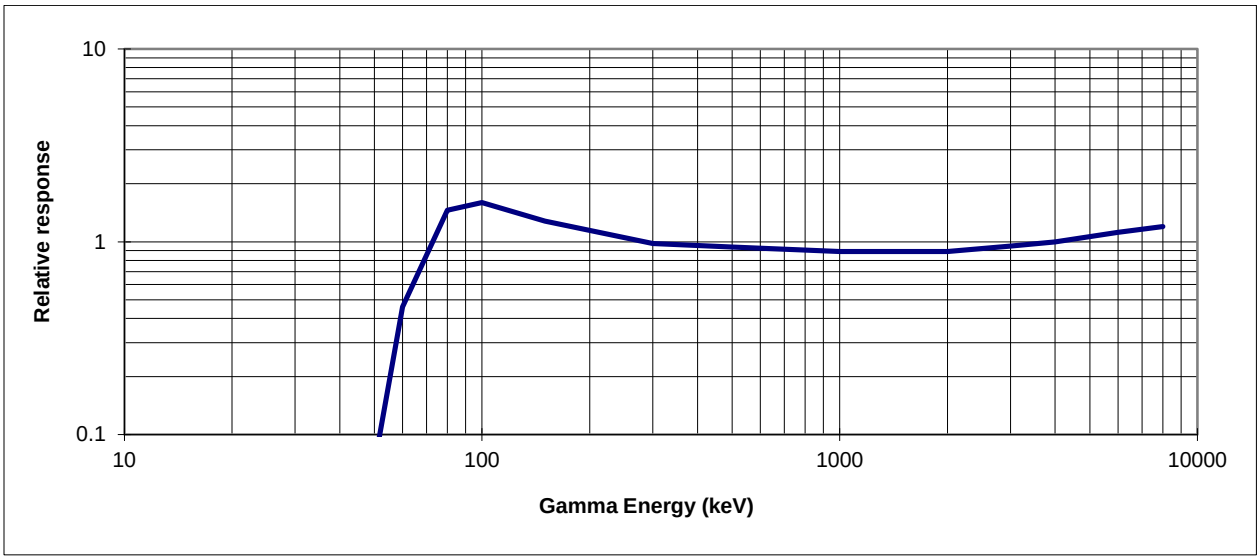


Figure 7 HPIC Energy Response

The response is not flat across the measurable energy range, and the ability to measure gamma's falls off below 60KeV. The result of this is that some isotopes over-respond and some under-respond as compared with the air equivalent standard. Overall, this difference is not great and in most applications it is not considered. One reason for this is that to apply a correction requires one to know the energy of the incident photons. If this is known, a correction factor can be applied. This factor, referred to as the "F" factor, is the correction to be applied to compensate for the non-ideal nature of the response. Since each isotope has a different response, the calibration of the detector must be referenced to a known isotope. For this sensor, the reference is Ra226.

### 4.1.2 Determining the "F" Factors

The first task is to calculate the normalized response for the isotopes. If the isotope emits one energy unit, this would be a matter of finding the response value on the Y-axis for the energy of the photons. Most isotopes, however, have more than one energy line. Each energy line and the percentage of that energy to the total must be considered. The factors for the most common elements are shown in Table 2.

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Table 2 "F" Factors for Common Isotopes

| Isotope | Energy (MeV) | F |
|---|---|---|
| Co-60 | 1.17, 1.21 | 0.89 |
| Cs-137 | 0.667 | 0.91 |
| Ra-226 | Various | 0.91 |
| Kr-85 | 0.5 | 0.94 |
| Kr-85m | 0.15, 0.3 | 1.19 |
| Kr-87 | 0.4, 0.85, 2.6 | 0.93 |
| Kr-88 | 0.19, 2.4, 0.85, 2.2,1.55 | 0.92 |
| Xe-133 | 0.081 | 1.46 |
| Xe-133m | 0.233 | 1.11 |
| Xe-135 | 0.25, 0.6 | 1.07 |
| Am-241 | 0.059 | 0.46 |

These values can be used to provide a correction factor if the source of the gamma field is known. Since the detector is calibrated with respect to Ra226 this correction is the ratio of the measured isotope to the Ra226 "F" factor. A table of these correction factors is shown in Table 3.

Table 3 Correction Factors

| | |
|---|---|
| Co-60 | 0.980 |
| Cs-137 | 1.002 |
| Ra-226 | 1.000 |
| Kr-85 | 1.035 |
| Kr-85m | 1.314 |
| Kr-87 | 1.027 |
| Kr-88 | 1.013 |
| Xe-133 | 1.608 |
| Xe-133m | 1.223 |
| Xe-135 | 1.178 |
| Am-241 | 0.507 |

To use these factors, assume you were measuring Co60 and a dose rate of 150uR/h was measured. To correct this reading this value should be divided by 0.98, yielding 153 µR/h.

### 4.1.3 Saturation Characteristics

The saturation of the detector is to ensure that all of the ions generated are measured. If the bias voltage is not high enough some of these ions recombine, which effectively means the output is no longer linear with exposure rate. The voltage required to collect all of the ions generated is termed the saturation voltage, which varies with the dose rate being measured. A typical saturation curve for dose rate levels of 1.0 and 10.0 mR/h is shown in Figure 8.

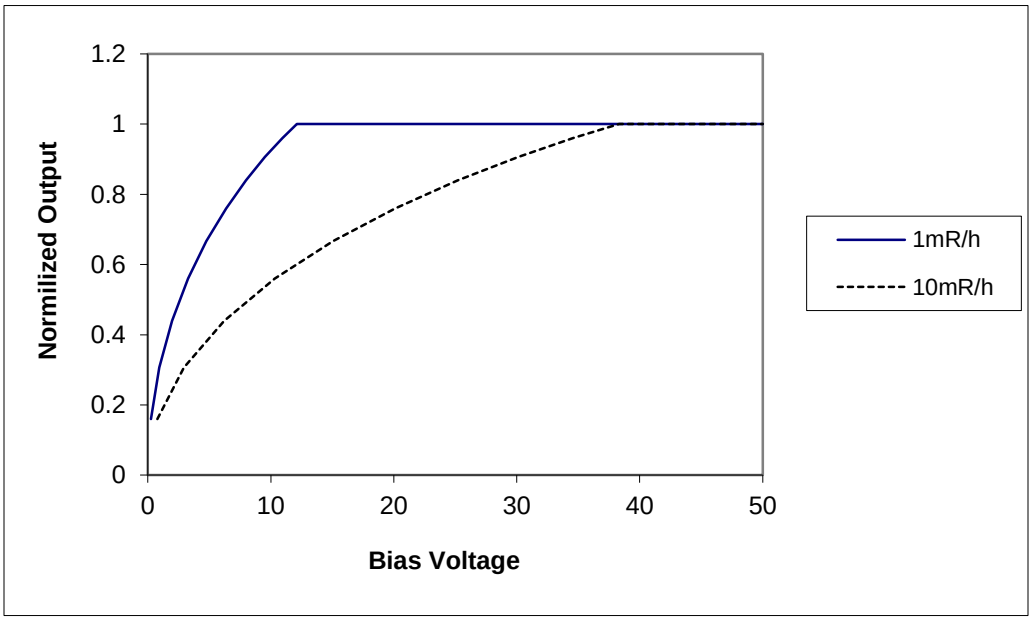


Figure 8 Saturation Curves

To ensure collection of all the ions a voltage of about 13 volts is required if the field is 1mR/h and a bias of 49 volts at 10mR/h. For the standard range of 100mR/h the saturation voltage is approximately 125 volts, which is well under the 400 volt bias voltage applied to the detector.

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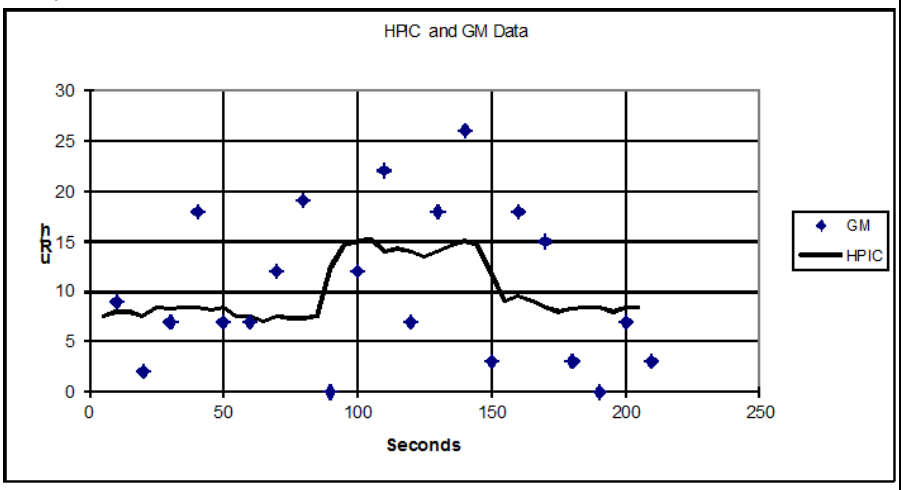
### 4.1.4 Measurement Characteristics

Table 4 provides measurement characteristics.

Table 4 Measurement Characteristics

| Term | Description |
|---|---|
| Accuracy | Accuracy is often misunderstood and can be confused with the statistical characteristics of the measurement. Accuracy is a measurement of how well the detector reports a reading relative to the actual radiation present, assuming the sampling time is long enough such that statistical errors are not significant.<br>Another component of accuracy is drift, primarily caused by temperature variations in the environment or long-term drifting over time. |
| Calibration Accuracy | The calibration technique is very important since it determines the underlying accuracy of the measurement. The accuracy of the calibration is affected by three major components: the radiation source accuracy, radiation field stability during calibration, and measurement error.<br>The radiation source used is nominal 12 mCi of Cs137 that is certified by NIST to an accuracy of ±3%. This certification establishes the best accuracy achievable.<br>Field variations during calibration are minimized by performing measurements with and without a lead shield in the path of the primary beam of radiation. By subtracting these two measurements, the background and the scattered components of the source are eliminated.<br>Last is the measurement error as a result of statistical and experimental error. Two techniques are used to minimize these errors: long averaging times and repeated calibrations at multiple distances. Averaging times are selected to reduce the statistical errors to a negligible amount in comparison to the 3% source accuracy. |
| Temperature Drift | Temperature drift is minimized in two ways in the design of the ion chamber system.<br>The first is by incorporating components that have low temperature coefficients. However, some characteristics of the electrometer are still sensitive to temperature, and in order to meet the drift specifications, the microprocessor firmware compensates for drift by using a series of constants that represent the characteristics of the electrometer.<br>These constants are determined by a test procedure performed on each electrometer. These values are entered into the electrometer's non-volatile memory. Storing these values within the electrometer means, in the situation where an electrometer requires replacement, no other action is necessary. |

| Term | Description |
|---|---|
| Statistical Response | The statistics of the measurement are very important to the determination of changes in dose rate. Basically, any radiation measurement has statistical variation associated with the measurement, due to the random nature of the gamma photons being measured. The more noise in the measurement, the longer one must average the signal for a given confidence level.<br>To illustrate this concept, Figure 9 shows data taken from the HPIC and a cylindrical GM counter. The "calibration" of each of these detectors may be the same, but the amount of time required to achieve a given statistical accuracy is quite different.<br>In this example, the field increased from 8 uR/h to 15 uR/h, but with the GM output, it is much less clear what actually happened during this period.<br>  <br>Figure 9 Statistical Response |
| Directional Response | One of the strengths of the HPIC is the angular response to incident photons. This is due to the spherical design of the detector as compared with cylindrical detectors that do not have $4\pi$ symmetry.<br>The directional characteristics are primarily due to the detector, but are also affected by the packaging and internal components of the sensor. Refer to the datasheet for specifications. |

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# 5 SOFTWARE CONFIGURATION UTILITY

The Configuration Utility is provided on CD with every unit. It allows the user to configure the unit and gather data. It is not a complete host system intended to poll multiple units for data.

REFER TO THE APPENDIX FOR LEGACY SOFTWARE CONFIGURATION AND UNSUPPORTED COMMANDS.

On startup the Configuration Utility first locates which RSDetection units are on the network. The user can then select the appropriate gamma monitor with which to communicate. This of course means the user must know the IP address or serial port of the desired unit. This is dependent on the customer network.

REFER TO THE APPENDIX FOR APPROPRIATE COMMANDS TO MANUALLY PROGRAM CONFIGURATION SETTINGS.

1. To open the Configuration Utility, double-click the icon on your desktop. The Discovery screen opens.

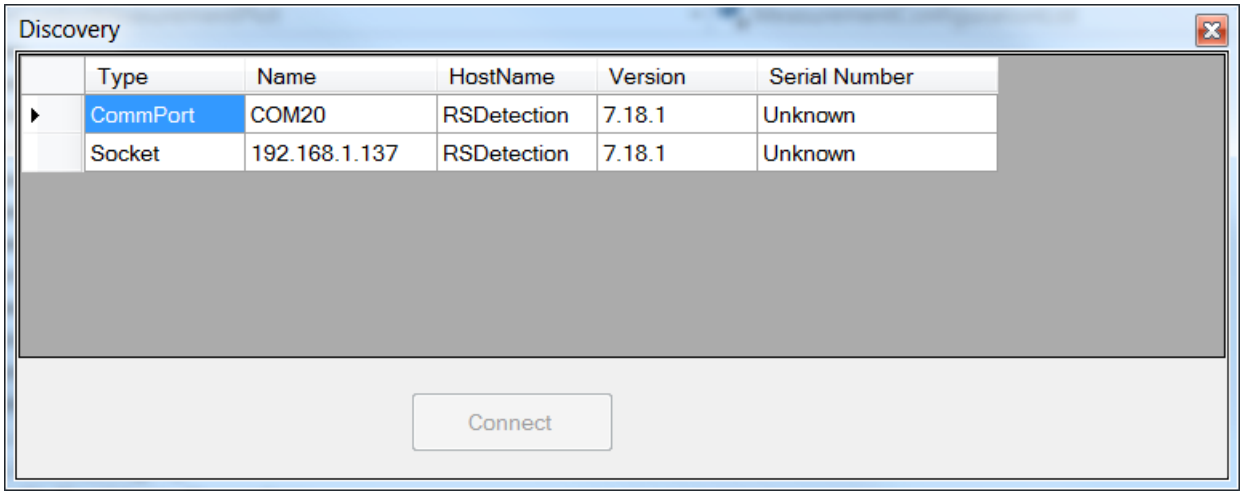


Figure 10 Discovery Screen

2. Select the appropriate gamma monitor by clicking the leftmost column on the desired row, and then click **Connect**.

## 5.1 Available Tabs

The Configuration Utility contains the following functions:

- **Events** – View the current state of the unit events.
- **Measurements** – View the value of all the measurements.
- **Configurations** – A list of configurations that can be viewed or modified.
- **Plots** – Measurements can be select and plotted in real time.
- **Event Log** – Provides the capability to enter a date/time period and the events logged for that period will be displayed.
- **History** – A start and end time are entered and a measurement selected. This measurement can then be plotted or listed in a tabular format for that period.

## 5.2 Main Menu Functions

A menu bar is located in the upper portion of the screen and is shown in the Figure 11.

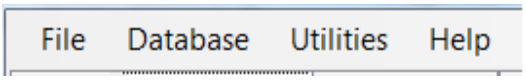


Figure 11 Main Menu

### 5.2.1 File Menu

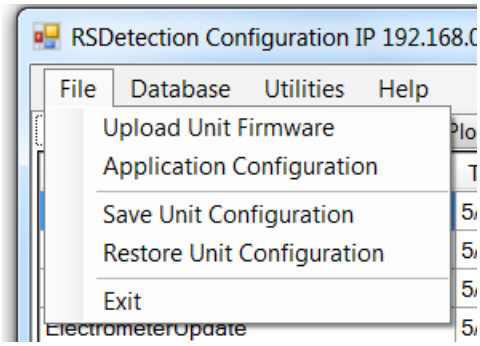


Figure 12 File Menu

**Upload Unit Firmware** – Firmware can be loaded into the unit using this menu selection. Selecting this item displays a **File Selection** dialog box to select a file containing the firmware update. This is a .cab file supplied by the manufacturer and when selected using this dialog box, it is copied to an FTP folder on the RSDetection file system. In order for the update to take effect, the unit must be power cycled, at which time the .cab file will be unpacked and the firmware copied to the proper location. Reference the Firmware section under Field Installation for a more detailed procedure.

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- **Application Configuration** – There are configurable parameters used to control the overall utility application. When selected, a dialog box similar to Figure 13 will be displayed. There are 3 configurable items listed that are default file folders for storing data:
- **DefaultConfigurationFolder** - The next section describes saving and restoring configurations. This folder will be used as the default location for this function.
- **DefaultSaveFolder** - In a number of functions there is an option to save data to a file. In those cases the file dialog box used to specify where the data will be saved defaults to the folder specified in this dialog.
- **LoggingFolder** - In the plotting tab data can be logged to a file as it is received. This folder will be used as the location for this data to be stored.

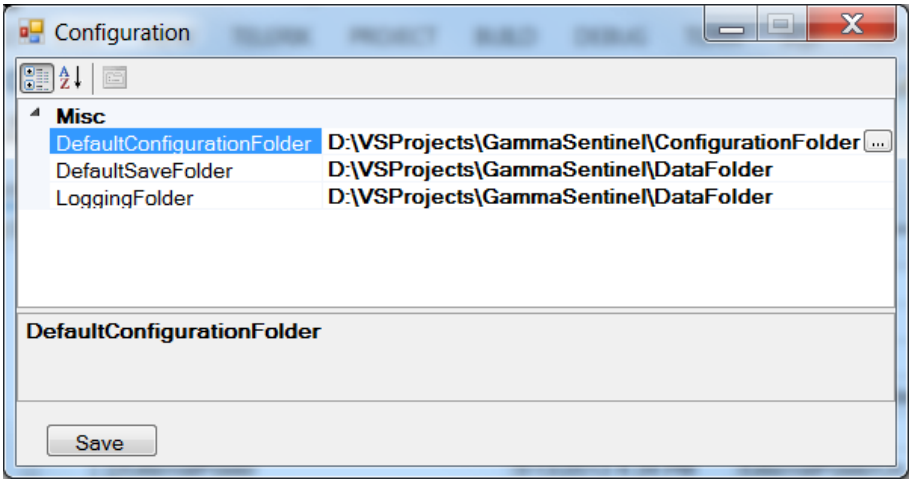


Figure 13 Application Configuration Screen

- **Save Unit Configuration** – There are many configuration options available and these are described in detail in the Configurations Tab section of the manual. Using this menu item, the configuration of the unit can be saved to a file. This file could then be used at a later time to restore the configuration. When selecting this item the **File** dialog box displays to allow for selecting a location and file name for the configuration. The default folder is determined by the application configuration options described in the prior section. The format of the data storage is an XML text-based file.
- **Restore Unit Configuration** –The configuration of the unit can be restored from a file previously saved using the Save Configuration function in the previous section. When selecting this item, the **File** dialog box displays to allow for selecting a location and file name for the configuration. The default folder is determined by the application configuration options described in the prior section. The format of the data storage is an XML text-based file.
- **Exit** –Exits the application and closes the connection with the unit.

### 5.2.2 Database Menu

- **Statistics** –Outputs the overall statistics of the database. This includes the oldest and newest measurements and events. Also displayed is the number of records for each category. A sample screen is shown in Figure 15.

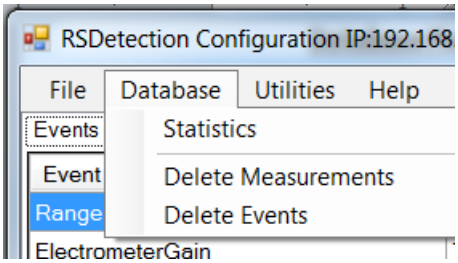


Figure 14 Database Menu

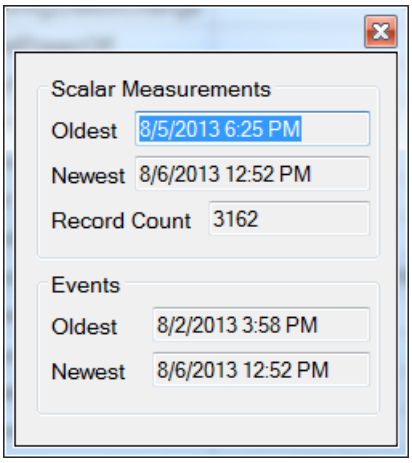


Figure 15 Database Statistics Screen

The statistics show the dates for the oldest and newest measurements as well as events. Note as database size becomes large, requesting database statistics may take over 10 seconds to complete.

- **Delete Measurements** – Deletes all measurement records in the scalar measurements table. Executing this command will result in the permanent loss of the data records.

- **Delete Events** – Deletes all event records in the event log. Executing this command will result in the permanent loss of the data records.

Records can be deleted based upon time or all may be deleted if the checkbox is selected, as shown in Figure 16.

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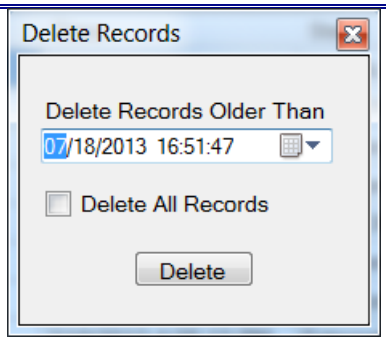


Figure 16 Delete Records Dialog Box

### 5.2.3 Utilities Menu

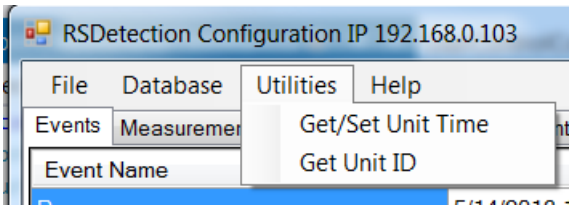


Figure 17 Utilities Menu

- **Get/Set Unit Time** –Sets the date and time of the unit as shown in Figure 18. There is a check box labeled **RSS-131 Compatible** located in the center of the dialog. This should only be checked if the unit is operated in legacy mode where the older commands are used.

  The reason for the optional selection is that the older commands are not time zone aware while the new commands are. For a more detailed discussion refer to the Time Zone section of the manual.

  There is also a separate button, **Set to PC Time**, which is a shortcut that enters the host PC time into the **Data** field and sends the command.

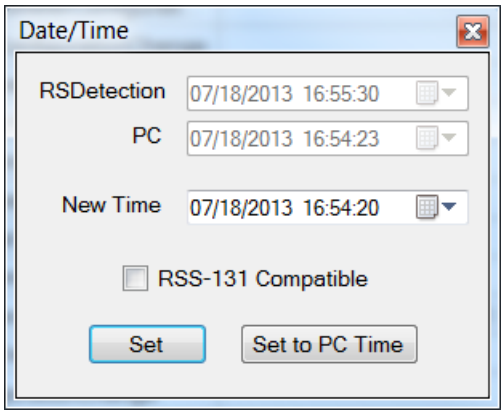


Figure 18 Date/Time Screen

- **Get Unit ID** – This read-only screen provides the serial numbers of the various system components along with the firmware version.

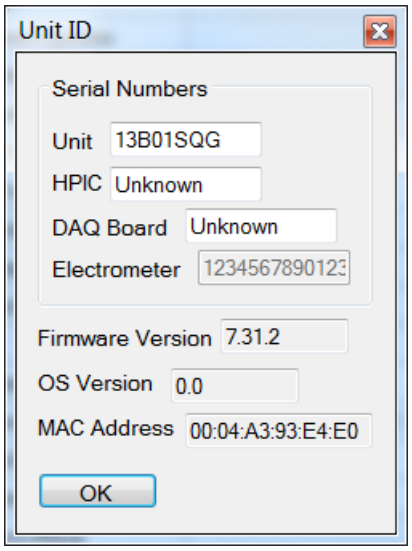


Figure 19 Unit ID Screen

### 5.2.4 Help Menu

- **About** - Displays the current configuration utility version.

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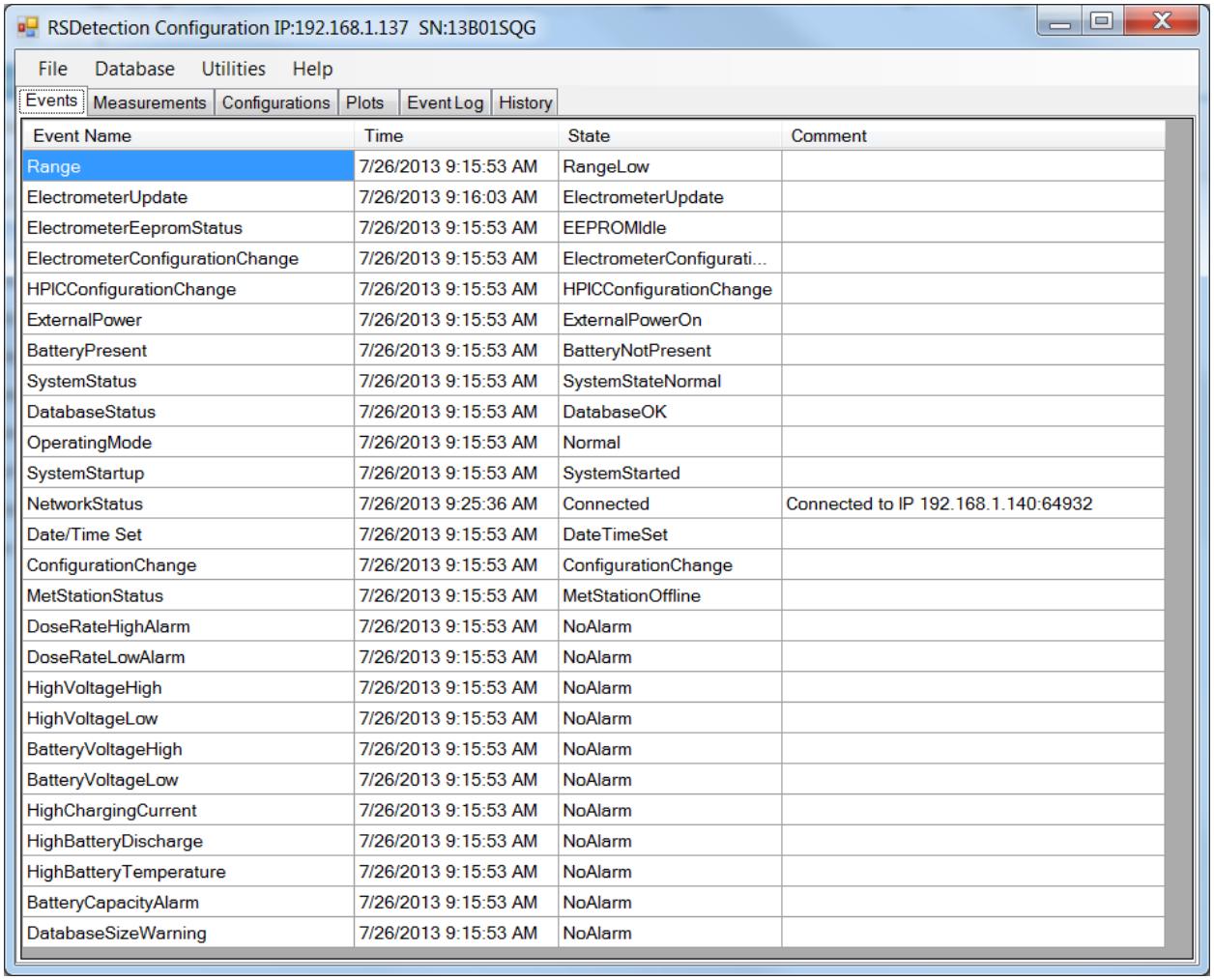
## 5.3 Configuration Utility Tabs

### 5.3.1 Events Tab

Displays the current status of the unit, which provides the name of the event, the current state, and the time it was checked.




| Event Name | Time | State | Comment |
|---|---|---|---|
| Range | 7/26/2013 9:15:53 AM | RangeLow | |
| ElectrometerUpdate | 7/26/2013 9:16:03 AM | ElectrometerUpdate | |
| ElectrometerEepromStatus | 7/26/2013 9:15:53 AM | EEPROMIdle | |
| ElectrometerConfigurationChange | 7/26/2013 9:15:53 AM | ElectrometerConfigurati... | |
| HPICConfigurationChange | 7/26/2013 9:15:53 AM | HPICConfigurationChange | |
| ExternalPower | 7/26/2013 9:15:53 AM | ExternalPowerOn | |
| BatteryPresent | 7/26/2013 9:15:53 AM | BatteryNotPresent | |
| SystemStatus | 7/26/2013 9:15:53 AM | SystemStateNormal | |
| DatabaseStatus | 7/26/2013 9:15:53 AM | DatabaseOK | |
| OperatingMode | 7/26/2013 9:15:53 AM | Normal | |
| SystemStartup | 7/26/2013 9:15:53 AM | SystemStarted | |
| NetworkStatus | 7/26/2013 9:25:36 AM | Connected | Connected to IP 192.168.1.140:64932 |
| Date/Time Set | 7/26/2013 9:15:53 AM | DateTimeSet | |
| ConfigurationChange | 7/26/2013 9:15:53 AM | ConfigurationChange | |
| MetStationStatus | 7/26/2013 9:15:53 AM | MetStationOffline | |
| DoseRateHighAlarm | 7/26/2013 9:15:53 AM | NoAlarm | |
| DoseRateLowAlarm | 7/26/2013 9:15:53 AM | NoAlarm | |
| HighVoltageHigh | 7/26/2013 9:15:53 AM | NoAlarm | |
| HighVoltageLow | 7/26/2013 9:15:53 AM | NoAlarm | |
| BatteryVoltageHigh | 7/26/2013 9:15:53 AM | NoAlarm | |
| BatteryVoltageLow | 7/26/2013 9:15:53 AM | NoAlarm | |
| HighChargingCurrent | 7/26/2013 9:15:53 AM | NoAlarm | |
| HighBatteryDischarge | 7/26/2013 9:15:53 AM | NoAlarm | |
| HighBatteryTemperature | 7/26/2013 9:15:53 AM | NoAlarm | |
| BatteryCapacityAlarm | 7/26/2013 9:15:53 AM | NoAlarm | |
| DatabaseSizeWarning | 7/26/2013 9:15:53 AM | NoAlarm | |

Figure 20 Events Tab On Electrometer Screen

Events, descriptions, and states are shown in Table 5. Each event has one or more possible states.

In the cases where more than one state is possible, an update to the event log and/or a notification will be sent if the state changes, assuming the event were configured to do so.

For those events with only one state such as Date/Time Set, the log or notification is written or activated whenever this action occurs, even though there is no change in state.

Table 5 Events

| Event | Event Description | State |
|---|---|---|
| Range | Indicates the current electrometer range. | RangeLow<br>RangeHigh |
| ElectrometerUpdate | This event is set whenever a new dose rate measurement is available. | ElectrometerUpdate |
| Electrometer EepromStatus | At startup and upon command an EEPROM test can be run and the results are reported with this event. | EEPROMIdle<br>EEPROMPass<br>EEPROMFail<br>EEPROMInvalidConfiguration |
| Electrometer ConfigurationChange | Set if any change to the electrometer configuration occurs. | Only used for event logging and will never change on this screen. |
| HPICConfigurationChange | Set if any change to the HPIC configuration occurs. | Only used for event logging and will never change on this screen. |
| External Power | Detects the presence or absence of external DC power. | Power Off<br>Power On |
| BatteryPresent | Indicates whether a battery is installed or not. | BatteryPresent<br>BatteryNotPresent |
| SystemStatus | A global indication as to whether alarms are active. | SystemStatusNormal<br>SystemAlarm |
| DatabaseStatus | Current database status. | DatabaseOK<br>DatabaseError |

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| Event | Event Description | State |
|---|---|---|
| OperatingMode | Indicates the current operating mode. No action is taken by the system to a state change other than logging and notification. It is up to the user to take action on this event state. | Normal<br>Offline<br>CheckSource |
| SystemStartup | During startup the unit will be in initialization mode followed by SystemStarted. This event can be used to determine when power was cycled or the unit restarted. | SystemInitializing<br>SystemStarted |
| NetworkStatus | Reflects the current connection to the TCP/IP network. | Connected<br>Disconected |
| Date/Time Set | Whenever the date/time is set this event is toggled. | DateTimeSet |
| ConfigurationChange | Set when any configuration parameter is changed. | ConfigurationChange |
| MetStationStatus | The current state of communication with the meteorological station. | MetStationOK<br>MetStationOffline<br>MetStationError |
| DoseRateHighAlarm | If the dose rate exceeds the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| DoseRateLowAlarm | If the dose rate is lower than the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |

| Event | Event Description | State |
|---|---|---|
| DoseRateVariationAlarm | The dose rate standard deviation percent measurement is used to determine if the variation in dose rate is higher than normal. If the percent exceeds the alarm value the event will become active. | NoAlarm<br>AlarmActive |
| HighVoltageHigh | If the high voltage bias exceeds the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| HighVoltageLow | If the high voltage bias is lower than the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| BatteryVoltageHigh | If the battery voltage exceeds the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| BatteryVoltageLow | If the battery voltage is lower than the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| HighChargingCurrent | If the battery charging current is higher than the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |

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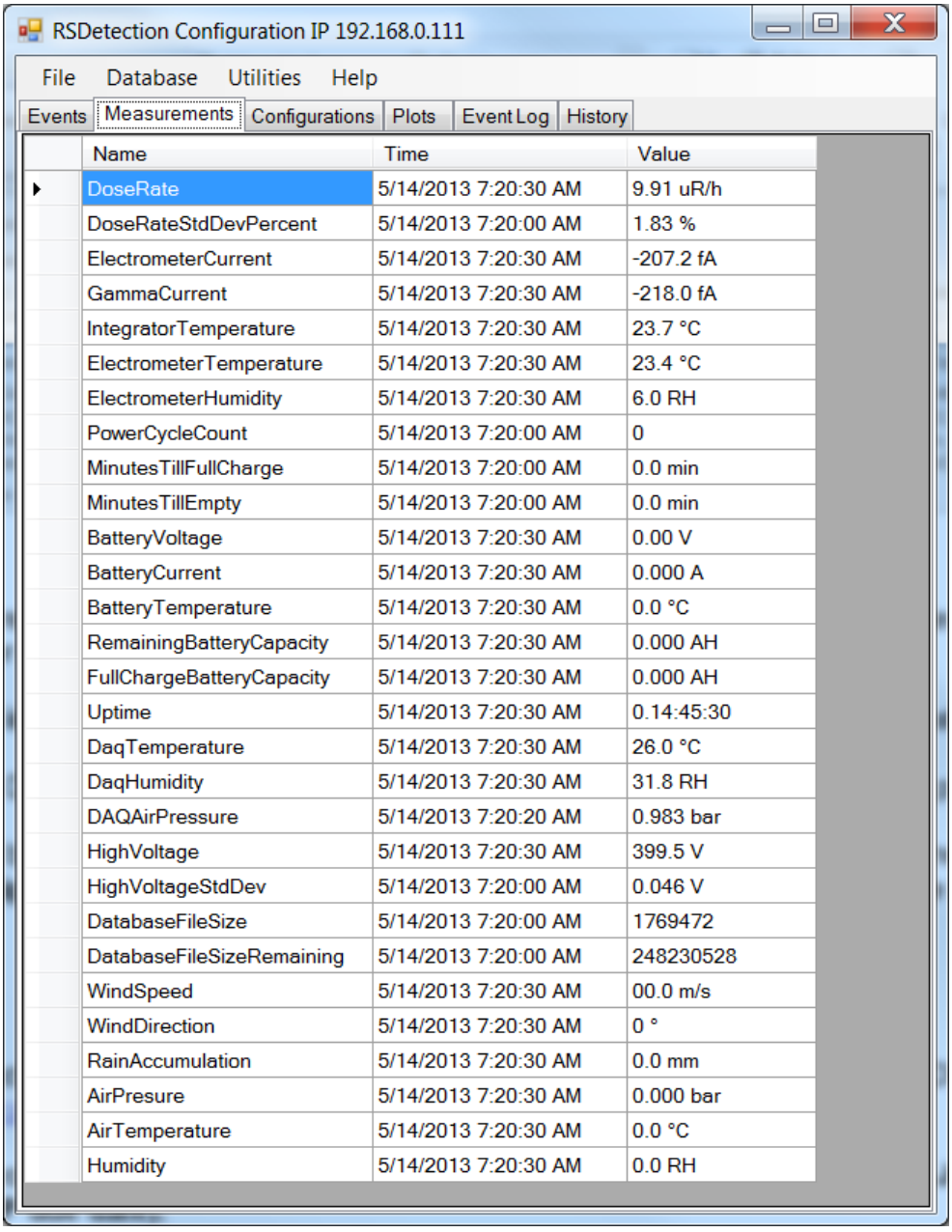
| Event | Event Description | State |
|---|---|---|
| HighBatteryDischarge | If the current supplied by the battery exceeds the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| HighBatteryTemperature | If the battery temperature exceeds the alarm limit specified in the event configuration this event will generate an alarm. | NoAlarm<br>AlarmActive |
| BatteryCapacityAlarm | If the PercentBatteryCapacity measurement falls below the alarm limit this event will alarm. | NoAlarm<br>AlarmActive |
| DatabaseSizeWarning | If the database file size exceeds 20% of the maximum allowable size this event will become active. | NoAlarm<br>AlarmActive |

### 5.3.2 Measurements Tab

Displays the current measurements of the unit including the type of measurement, the value and the time the measurement was taken. Individual values will update at the recording interval specified for that measurement.




| Name | Time | Value |
|---|---|---|
| DoseRate | 5/14/2013 7:20:30 AM | 9.91 uR/h |
| DoseRateStdDevPercent | 5/14/2013 7:20:00 AM | 1.83 % |
| ElectrometerCurrent | 5/14/2013 7:20:30 AM | -207.2 fA |
| GammaCurrent | 5/14/2013 7:20:30 AM | -218.0 fA |
| IntegratorTemperature | 5/14/2013 7:20:30 AM | 23.7 °C |
| ElectrometerTemperature | 5/14/2013 7:20:30 AM | 23.4 °C |
| ElectrometerHumidity | 5/14/2013 7:20:30 AM | 6.0 RH |
| PowerCycleCount | 5/14/2013 7:20:00 AM | 0 |
| MinutesTillFullCharge | 5/14/2013 7:20:00 AM | 0.0 min |
| MinutesTillEmpty | 5/14/2013 7:20:00 AM | 0.0 min |
| BatteryVoltage | 5/14/2013 7:20:30 AM | 0.00 V |
| BatteryCurrent | 5/14/2013 7:20:30 AM | 0.000 A |
| BatteryTemperature | 5/14/2013 7:20:30 AM | 0.0 °C |
| RemainingBatteryCapacity | 5/14/2013 7:20:30 AM | 0.000 AH |
| FullChargeBatteryCapacity | 5/14/2013 7:20:30 AM | 0.000 AH |
| Uptime | 5/14/2013 7:20:30 AM | 0.14:45:30 |
| DaqTemperature | 5/14/2013 7:20:30 AM | 26.0 °C |
| DaqHumidity | 5/14/2013 7:20:30 AM | 31.8 RH |
| DAQAirPressure | 5/14/2013 7:20:20 AM | 0.983 bar |
| HighVoltage | 5/14/2013 7:20:30 AM | 399.5 V |
| HighVoltageStdDev | 5/14/2013 7:20:00 AM | 0.046 V |
| DatabaseFileSize | 5/14/2013 7:20:00 AM | 1769472 |
| DatabaseFileSizeRemaining | 5/14/2013 7:20:00 AM | 248230528 |
| WindSpeed | 5/14/2013 7:20:30 AM | 00.0 m/s |
| WindDirection | 5/14/2013 7:20:30 AM | 0 ° |
| RainAccumulation | 5/14/2013 7:20:30 AM | 0.0 mm |
| AirPresure | 5/14/2013 7:20:30 AM | 0.000 bar |
| AirTemperature | 5/14/2013 7:20:30 AM | 0.0 °C |
| Humidity | 5/14/2013 7:20:30 AM | 0.0 RH |

Figure 21 Measurements Tab On Electrometer Test Screen

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Measurements, descriptions, and units are shown in the Table 6.

Table 6 Measurements

| Measurement | Measurement Description | Unit(s) |
|---|---|---|
| DoseRate | The gamma dose rate. | R/h (*)<br>Sv/h<br>Gy/h |
| DoseRateStdDevPercent | This is the standard deviation as a percent of reading for the dose rate. | % |
| IntegratorTemperature | The measured temperature inside the shield cover within the electrometer. | °C (*)<br>°F |
| ElectromenterTemperature | The temperature inside the electrometer can be outside of the shield cover. | °C (*)<br>°F |
| ElectromenterHumidity | The humidity inside the shield cover within the electrometer. | RH |
| PowerCycleCount | The number of charging cycles the battery has experienced. | count |
| MinutesTillFullCharge | Number of minutes till full charge as determined by the battery charger. | minutes |
| MinutesTillEmpty | Number of minutes till the battery is empty as determined by the battery charger. | minutes |
| Battery Voltage | Current voltage of the battery. | volts |
| BatteryCurrent | Current being supplied by the battery. Current being supplied by the battery to power the unit is indicated as a negative number while current going into the battery during a charging cycle is positive. | amps |
| BatteryTemperature | Temperature of the battery. | °C (*)<br>°F |
| RemainingBatteryCapacity | Estimated capacity remaining in the battery. | Amp-hours |
| FullChargeBatteryCapacity | Estimated full charge capacity of the battery. | Amp-hours |
| PercentBatteryCapacity | Estimated full charge capacity as a percent of design capacity. | % |
| Uptime | The amount of time the unit has been running. If power is cycled this number will return to zero. | Time Span |
| DaqTemperature | Temperature measured on the DAQ board. | °C (*)<br>°F |
| DaqHumidity | Humidity measured on the DAQ board. | RH |

| Measurement | Measurement Description | Unit(s) |
|---|---|---|
| DaqAirPressure | Pressure measured on the DAQ board. Due to the sealed nature of the enclosure this may not accurately reflect the exterior pressure. | bar (*)<br>kP<br>psi |
| HighVoltage | The bias voltage applied to the HPIC | volts |
| HighVoltageStdDev | The bias voltage standard deviation as measured since the last measurement. | volts |
| DatabaseFileSize | Current size of the SQL database file. | bytes |
| DatabaseRecordCount | The number of measurements stored in the database. | Record Count |
| WindSpeed | Wind speed as measured by the option metrological sensor. Will be zero if no sensor installed. | m/s (*)<br>k/h<br>mph |
| WindDirection | Wind direction as measured by the optional metrological sensor. If the sensor is not installed, a value of zero will be recorded. | degrees |
| RainAccumulation | Rainfall as measured by the optional metrological sensor. This measurement will be reset to zero after every measurement. If the sensor is not installed, a value of zero will be recorded. | mm (*)<br>Cm<br>inches |
| AirPresure | Air pressure as measured by the optional metrological sensor. If the sensor is not installed, a value of zero will be recorded. | bar (*)<br>kPa, psi, mmHg, inHg |
| AirTemperatue | Air temperature as measured by the optional metrological sensor. If the sensor is not installed, a value of zero will be recorded. | °C (*)<br>°F |
| Humidity | Humidity as measured by the optional metrological sensor. If the sensor is not installed, a value of zero will be recorded. | bar (*)<br>kPa, psi, mmHg, inHg |

* DESIGNATES THE DEFAULT UNIT IF MORE THAN 1 UNIT CAN BE SELECTED.

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### 5.3.3 Configurations Tab

Displays the current configuration of various components of the unit. RSDetection is installed with default configurations which can be customized.

1. Click the **Configuration** tab to display the Configuration screen. A list of configurations is displayed.
2. A dropdown menu in the upper-left portion of the screen can be used to limit the number of displayed configurations. This filtering is done by category. The following categories can be selected:
   - Scalar Measurements
   - Composite Measurements
   - Events
   - Alarm Events
   - Serial Ports
   - System
3. Once selected, a list of configurations display on the screen.

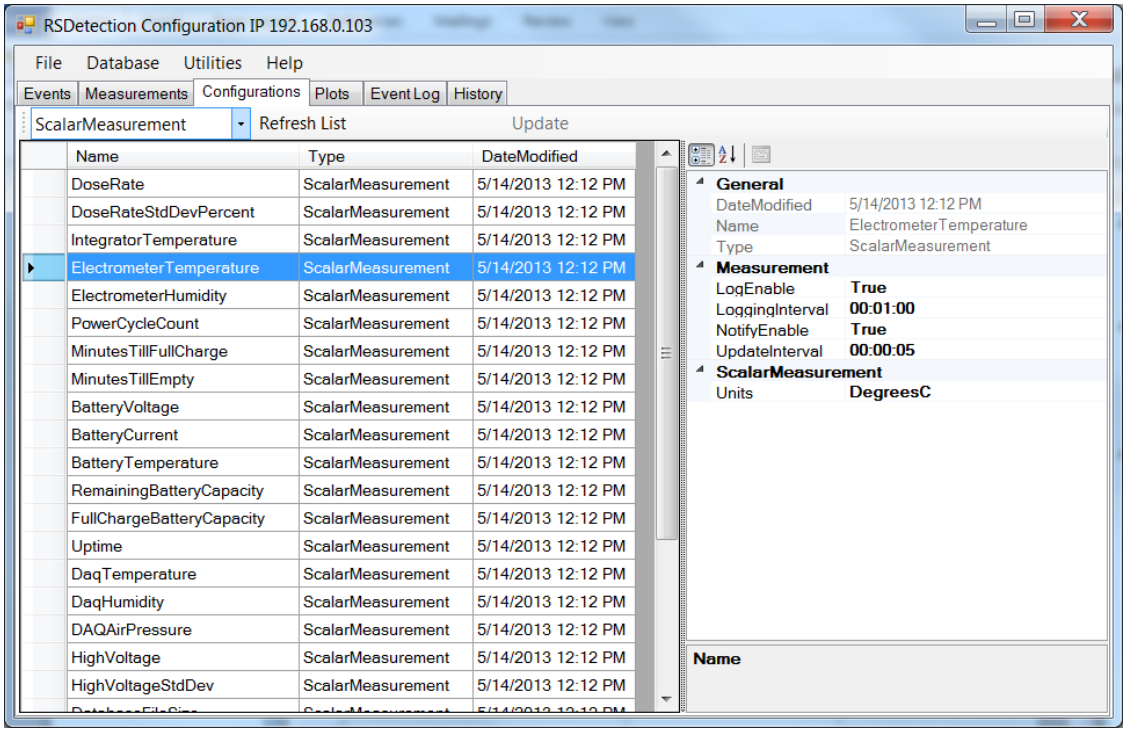


Figure 22 Configurations Tab On Electrometer Test Screen

4. To view all the configurations, simply scroll through the list or click the down arrow next to drop-down box above the list of configurations.

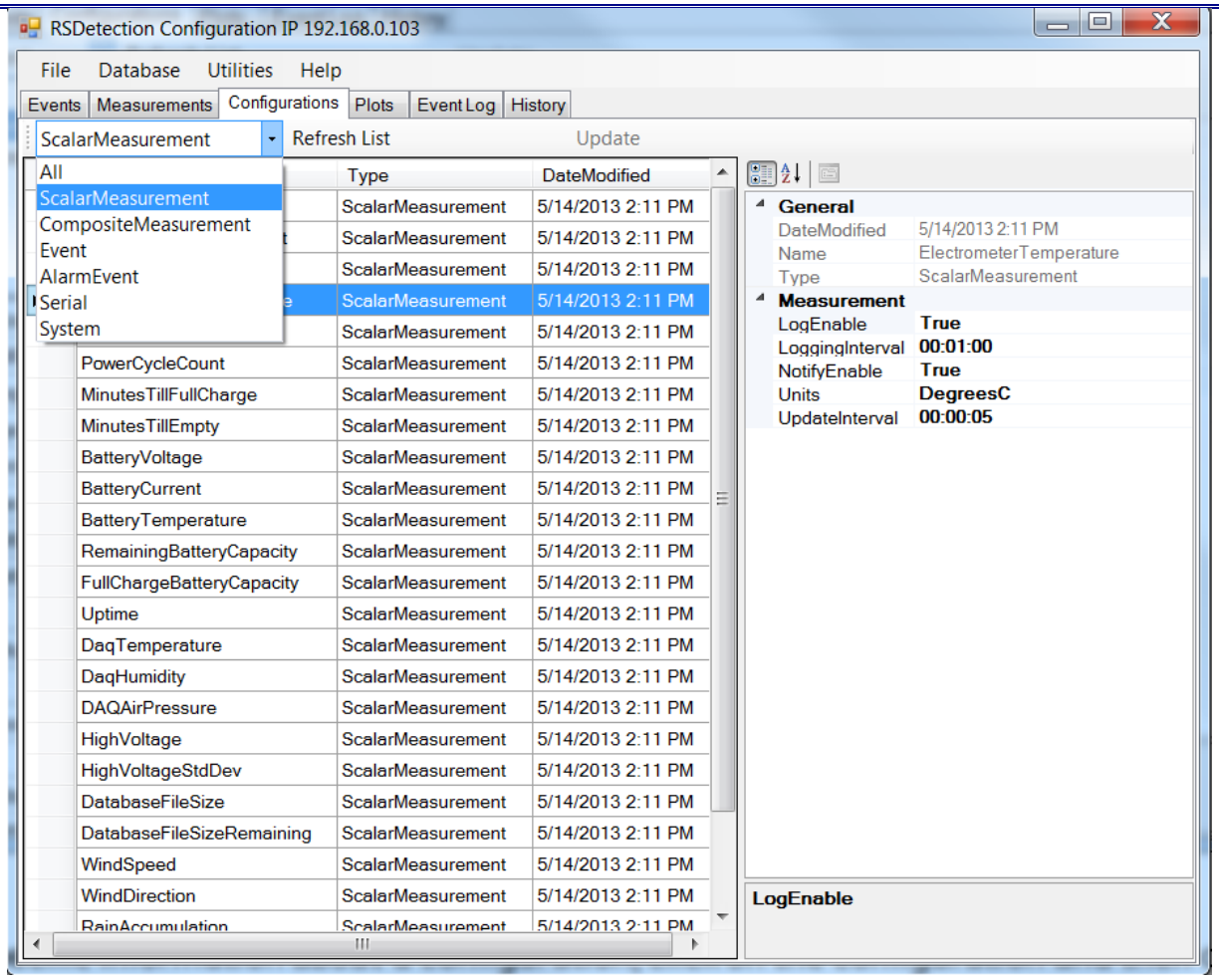


Figure 23 Configuration Types

5. To view specific information about a configuration, click on the configuration and then click the arrow to the left of the configuration name. The parameters for the selected item are displayed in the property grid on the right side of the screen. The properties are organized by either category or alphabetic order. To change between these 2 displays, select the appropriate item on the property grid as illustrated in Figure 24.

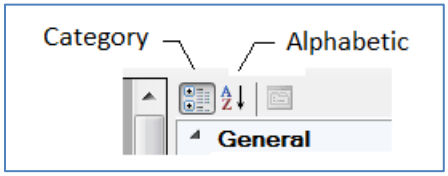


Figure 24 Property Grid

6. To change a variable definition of a specific parameter, click its name. If it is a selection box, a list of choices will be presented. If a text field, the value must be typed into the text box.

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Configuration types, parameters, variables, and their descriptions, along with variable default and optional settings are listed in Table 7 through Table 15.

#### 5.3.3.1 Common Configuration Parameters

Every configuration has a number of general properties that are read-only but appear under the category of "General." Since they are common, they will only be described below and not repeated for each type of configuration.

Table 7 General Configuration Parameters

| Parameter | Variable | Property Description | Default Setting | Optional Settings |
|---|---|---|---|---|
| General | Date Modified | Date the parameter was modified. | Cannot be changed manually | Cannot be changed manually |
| | Name | Name of the parameter. | Cannot be changed manually | Cannot be changed manually |
| | Type | The type of the parameter:<br>Event<br>ScalarMeasurement<br>CompositeMeasurement<br>System<br>SerialPort | Cannot be changed manually | Cannot be changed manually |

#### 5.3.3.2 Scalar Measurement Configuration Parameters

Every measurement has a number of properties that govern its behavior. These are described in Table 8.

Table 8 Scalar Measurement Configuration Parameters

| Category | Parameter | Property Description | Choices |
|---|---|---|---|
| Measurement | LogEnable | If true, measurement will be logged whenever it is updated. | True<br>False |
| | LoggingIntervalSpan | The database logging interval. | Manually type |
| | NotifyEnable | If true, a notification will be sent whenever an update occurs. | True<br>False |
| | UpdateIntervalSpan | The interval between measurement updates. | Manually type |
| | Units | Measurement units for display. | Measurement dependent |
| | DoseRateTimeConstant* | The dose rate time constant. | Manually type |
| | RoentgenToSievert* | Conversion factor to convert Roentgen to Sievert. | Manually type |

* Applies to the Dose Rate scalar measurement only

#### 5.3.3.3 Composite Measurement Configuration Parameters

Table 9 Composite Measurement Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Measurement | LogEnable | If true, measurement will be logged whenever it is updated. | True<br>False |
| | LoggingIntervalSpan | The database logging interval. | Manually type |
| | NotifyEnable | If true, a notification will be sent whenever an update occurs. | True<br>False |
| | UpdateIntervalSpan | The interval between measurement updates. | Manually type |

#### 5.3.3.4 Event Configuration Parameters

Table 10 Event Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Event | LogOnChange | If true, the event will be logged to the database when it changes state. | True<br>False |
| | Notify | Determines when a notification message is sent. OnChange send when the event changes state. Always sends notification when the state is sampled even if it did not change state. This selection is only used for events with a single state such as DateTimeSet. Disable prevents the event from sending notifications. | OnChange<br>Always<br>Disable |

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#### 5.3.3.5 Alarm Configuration Parameters

Alarms are a special case of events. They share parameters, but add those properties necessary to determine when an alarm will occur.

Table 11 Alarm Event Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Alarm | AlarmEnable | If true, the alarm event is enabled. | True<br>False |
| | AlarmValue | The value of the alarm level. | Manually type |
| | Measurement Name | The name of the measurement for which the alarm event will use in determining if the alarm level has been reached. | Read Only |
| | TypeOfAlarm | Can be GreaterThan, LessThan or PercentageChange. | Read Only |
| Event | LogOnChange | If true, the event will be logged to the database when it changes state. | True<br>False |
| | Notify | Determines when a notification message is sent. OnChange send when the event changes state. Always sends notification when the state is sampled even if it did not change state. This selection is only used for events with a single state such as DateTimeSet. Disable prevents the event from sending notifications. | OnChange<br>Always<br>Disable |

#### 5.3.3.6 Serial Port Configuration Parameters

The number of serial ports available for configuration (if any) is determined by the number of USB to serial port adapters connected. A serial port requiring configuration is enabled within the RSDetector unit for each device connected.

Table 12 Serial Ports Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| SerialPort | BaudRate | Determines the BAUD rate of the serial port. | A drop down list determines the choices. |
| | NumberOfBits | The number of bits used in the transmission of a character. | 7 or 8 |
| | Parity | Parity of the transmitted byte. | A drop down list determines the choices or Even, Odd or None. |

#### 5.3.3.7 RSDetection Configuration Parameters

This selection covers a number of properties that govern the overall system operation.

Table 13 RSDetection Configuration

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Control | BiasVoltageOnAt Startup | If true, the high voltage bias (nominally 400V) will be applied at startup. | True<br>False |
| | LoggingEnable | A global enable that when false will disable all logging and if true logging will be determined by the measurement or event configuration. | True<br>False |
| | NotifyEnable | A global enable that when false will disable all notifications and if true logging will be determined by the measurement or event configuration. | True<br>False |
| Legacy | DateFormat | The older units allowed for 3 types of date output. This corresponds to the legacy DTF command. | MM_DD_YY<br>DD_MM_YY<br>YY_MM_DD |
| | UnitAddress | The legacy commands used a single character address for selecting which unit was being addressed. This corresponds to the UID legacy command. | Single character from '0' to 'Z' excluding '@' |

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| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Network | DefaultGateway | Typically the address of the router that provides the default routing functions. | Manually typed Format must be in dotted decimal notation using 4 numbers separated by periods. |
| | EnablePingConnections | | TRUE<br>FALSE |
| | StaticIPAddress | The IP address to be assigned if static address assignment is enabled. | Manually typed Format must be in dotted decimal notation using 4 numbers separated by periods. |
| | SubnetMask | A mask used by the router to route network messages. | Manually typed Format must be in dotted decimal notation using 4 numbers separated by periods. |
| | UnitName | This will set the network name that could be used by a DNS service to locate the unit. Size is limited to 15 characters and the first character must be a letter. | Manually typed |
| | UseStaticIPAddress | If true, the following 3 parameters will be used to set the IP address. | True<br>False |

#### 5.3.3.8 Display Configuration Parameters

For backward compatibility, a serial display can be used to display the dose rate output. These devices were used in the last generation of RSS-131 products and also may be configured as described in Table 14.

Table 14 Display Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| Display | CommPort | Determines the communication port that the display is connected to. Typically this is COM2 which is the dedicated serial port but COM1 or COM4 can be used if optional USB-to-serial adapters are used. | A drop-down list determines the choices. (COM1, COM3 or COM4) |
| | DisplayEnabled | Must be true for the unit to output serial data to the display. | True<br>False |

#### 5.3.3.9 Weather Station Configuration Parameters

An optional meteorological sensor is supported via a serial communication link with the RSDetection unit. Parameters to enable the data collection are shown in Table 15.

Table 15 Weather Station Configuration Parameters

| Parameter | Variable | Property Description | Choices |
|---|---|---|---|
| WeatherStation | CommPort | Determines the communication port that the station is connected to. Typically this may be COM2 which is the dedicated serial port but also could use COM1 or COM4 if optional USB to serial adapters are used. | A drop down list determines the choices. (COM1, COM3 or COM4) |
| | Model | The manufactured model number of the sensor. Currently only a Vaisala model WXT520 is supported. | A drop down list determines the choices. (WXT520) |
| | Enabled | True to enable connection and data collection. | True<br>False |

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### 5.3.4 Plots Tab

The Plots tab displays the system measurements on a graph in real time. The following options display across the top of the screen:

- **Clear plots** – Erases data on the graph.
- **Enable/Disable Logging** - Enabling logging will write the highlighted measurements into a .csv text file. As each new value is received from the unit, a new line in the file will be written. The files will be written to the folder specified in the LoggingFolder property in the ApplicationConfiguration described in the Main Menu Functions section of the manual. To highlight a measurement, the check box next to the measurement must be checked and the name of the measurement clicked. The name of the file will be the measurement name followed by the date and time. For example, a log file name for DaqTemperature may be "DaqTemperature_05_15_2013_12_52_38.csv".
- **Scale Y-Axis** – Adjust the y-axis on the graph for different measurement increments by typing the minimum and maximum measurements.
- **Scale X-Axis** – Adjust the x-axis on the graph for the total time visible on the graphic by typing the number of minutes to see.

To select the measurement to view, click the **Select** check box to the left of the measurement. The name of the measurement is highlighted in a color that corresponds to the colors on the graph. The x-axis displays the time the reading was taken. The y-axis displays the units of measure in the corresponding color. The data measurements are shown on the graph in the corresponding colors.

If you select a new measurement to view, a vertical line appears on the graph at the time you started the reading. Up to 4 measurements can be selected.

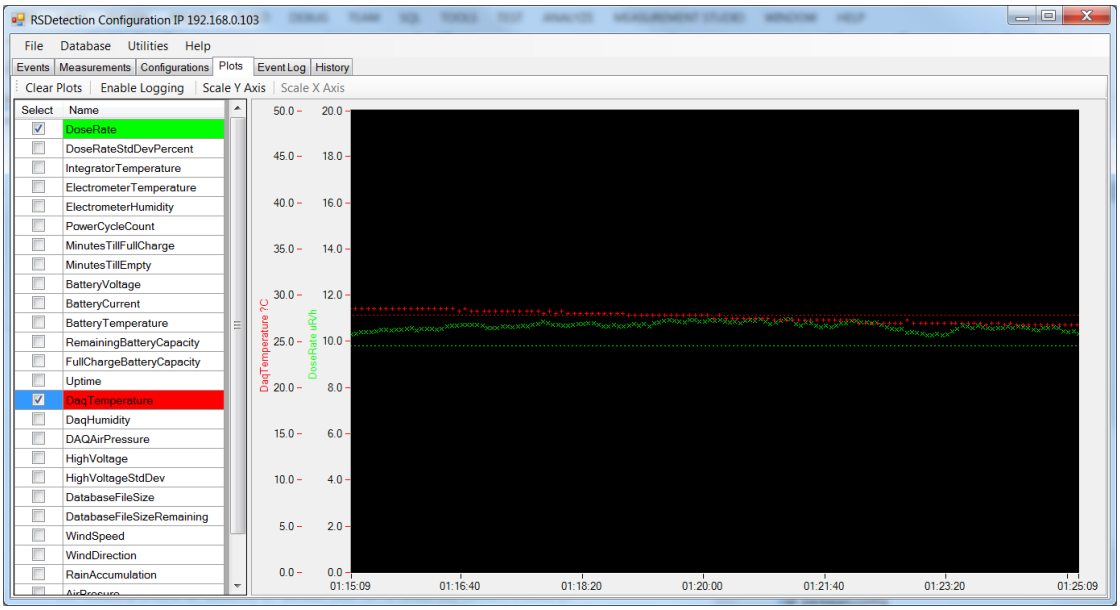
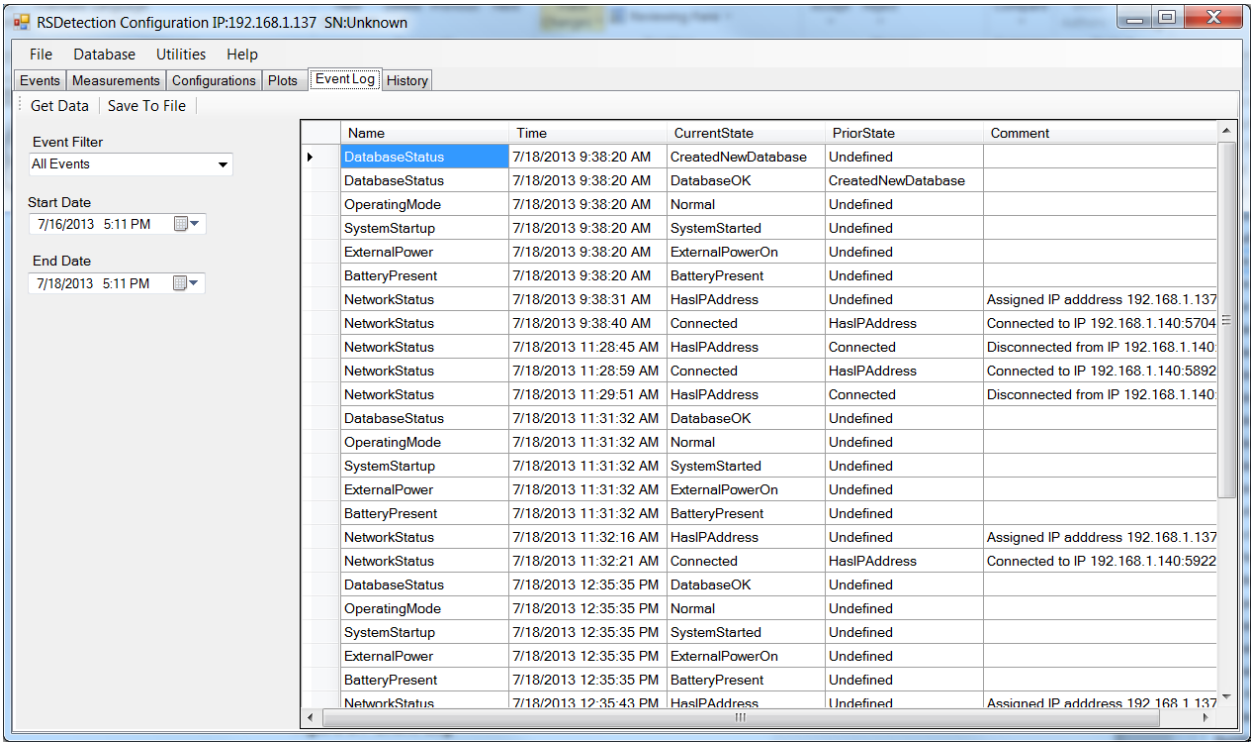



Figure 25 Plots Tab

### 5.3.5 Event Log Tab

The Event Log tab displays the details of any event within a set timeframe on the Event Log screen. The interpretation of the time will depend on the Windows regional settings. Refer to the Region and Language formats tab in the Computer Settings.

1. To set a range of time in which to view all events, click the down arrow next to the calendar to select the date in the **State Date** field.
2. Type the time in the **Start Time** field.
3. Click the down arrow next to the calendar to select the date in the **End Date** field.
4. Type the time in the **End Time** field.
5. Click **Get Event**. All events for that time period appear on the right side of the screen.
6. Once data has been collected it may also be saved to a text file by clicking on the **SaveToFile** button.




| Name | Time | CurrentState | PriorState | Comment |
|---|---|---|---|---|
| DatabaseStatus | 7/18/2013 9:38:20 AM | CreatedNewDatabase | Undefined | |
| DatabaseStatus | 7/18/2013 9:38:20 AM | DatabaseOK | CreatedNewDatabase | |
| OperatingMode | 7/18/2013 9:38:20 AM | Normal | Undefined | |
| SystemStartup | 7/18/2013 9:38:20 AM | SystemStarted | Undefined | |
| ExternalPower | 7/18/2013 9:38:20 AM | ExternalPowerOn | Undefined | |
| BatteryPresent | 7/18/2013 9:38:20 AM | BatteryPresent | Undefined | |
| NetworkStatus | 7/18/2013 9:38:31 AM | HasIPAddress | Undefined | Assigned IP adddress 192.168.1.137 |
| NetworkStatus | 7/18/2013 9:38:40 AM | Connected | HasIPAddress | Connected to IP 192.168.1.140:5704 |
| NetworkStatus | 7/18/2013 11:28:45 AM | HasIPAddress | Connected | Disconnected from IP 192.168.1.140 |
| NetworkStatus | 7/18/2013 11:28:59 AM | Connected | HasIPAddress | Connected to IP 192.168.1.140:5892 |
| NetworkStatus | 7/18/2013 11:29:51 AM | HasIPAddress | Connected | Disconnected from IP 192.168.1.140 |
| DatabaseStatus | 7/18/2013 11:31:32 AM | DatabaseOK | Undefined | |
| OperatingMode | 7/18/2013 11:31:32 AM | Normal | Undefined | |
| SystemStartup | 7/18/2013 11:31:32 AM | SystemStarted | Undefined | |
| ExternalPower | 7/18/2013 11:31:32 AM | ExternalPowerOn | Undefined | |
| BatteryPresent | 7/18/2013 11:31:32 AM | BatteryPresent | Undefined | |
| NetworkStatus | 7/18/2013 11:32:16 AM | HasIPAddress | Undefined | Assigned IP adddress 192.168.1.137 |
| NetworkStatus | 7/18/2013 11:32:21 AM | Connected | HasIPAddress | Connected to IP 192.168.1.140:5922 |
| DatabaseStatus | 7/18/2013 12:35:35 PM | DatabaseOK | Undefined | |
| OperatingMode | 7/18/2013 12:35:35 PM | Normal | Undefined | |
| SystemStartup | 7/18/2013 12:35:35 PM | SystemStarted | Undefined | |
| ExternalPower | 7/18/2013 12:35:35 PM | ExternalPowerOn | Undefined | |
| BatteryPresent | 7/18/2013 12:35:35 PM | BatteryPresent | Undefined | |
| NetworkStatus | 7/18/2013 12:35:43 PM | HasIPAddress | Undefined | Assigned IP adddress 192.168.1.137 |

Figure 26 Event Log

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### 5.3.6 History Tab

The History tab displays the historical data for a specific measurement. You can set a specific time period in which to view the historical information for a specific measurement. The interpretation of the time will depend on the regional settings of Windows. Refer to the Region and Language formats tab in the Computer Settings.

1. To select a measurement, click the arrow in the **Measurement** field.
2. Select the beginning date in the **Start Date** field.
3. Type the time in the **Start Time** field.
4. Select the ending date in the **End Date** field.
5. Type the time in the **End Time** field.
6. Click **Get Data**. The historical information is displayed on the graph where the x-axis shows the time the measurement was taken and the y-axis shows the measurement.

Data can optionally be displayed in list or plot format by using the **View** menu item.

Once data has been collected it may also be saved to a text file by clicking **SaveToFile**.

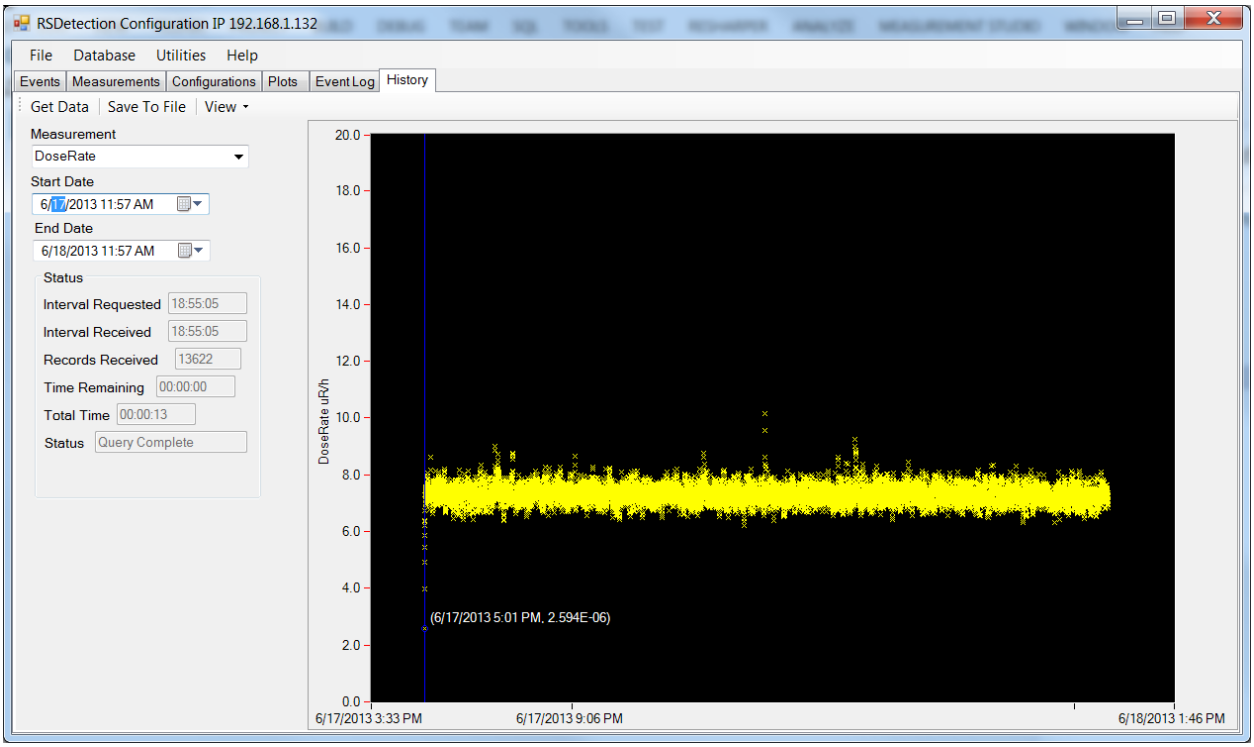


Figure 27 History Tab

# 6 CALIBRATION

Calibration is accomplished by placing the RSDetection in a well-defined radiation field and adjusting calibration constants to produce a prescribed output. The exact details of a user's calibration procedure depend upon the equipment and resources available as well as the user requirements.

It is recommended to implement a rapid method of checking sensor calibration. The intent is to identify substantial changes in instrument calibration. The check consists of establishing a reproducible arrangement of a long half-life isotopic source (e.g. Cs137) and the installed sensor. The increase in the sensor indication above background due to the check source is proportional to the sensitivity of the sensor. Any change in this indication is evidence of a change in calibration.

To perform this check:

1. Calculate an average value for background by averaging readings over a five-minute time period.
2. Place the check source in a reproducible location corresponding to the center of the chamber.
3. Average the readings for approximately two minutes.
4. Subtract the background value from the check source value to obtain the increase due to the source. This value should be constant if the calibration does not change. This method should be reproducible to within about 1% if carefully performed.

## 6.1 SCOPE

The following calibration procedure tests the sensor in the low range and identifies if the RAC parameter of the system should be adjusted.

OBSERVE RADIATION SAFETY PRACTICES WHEN WORKING WITH A RADIOACTIVE SOURCE. DUE TO THE WEIGHT OF THE LEAD SHIELD, MAKE SURE THAT THE STAND HOLDING THE SOURCE IS STABLE.

This procedure uses a "shadow shield" method using a Cs137 source. It includes instructions for averaging readings made at different field strengths, calculating instrument sensitivity in amps (A) per roentgen (R) per hour, and converting that figure to sensitivity relative to a Ra226 spectrum.

A procedure is included for adjusting the sensitivity parameter of the system, if required, to bring the instrument into specified tolerance. The number of measurements taken and the distances used are determined by the calibration system designers. The sample calculations show measurements taken at 12, 14, 16, and 18 feet.

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## 6.2 Test Equipment and Set-up

The following table and procedure provide the necessary equipment and set-up to perform the sensor calibration test.

Table 16 Test Equipment and Materials

| Equipment | Description |
|---|---|
| Data collection system | Monitors and averages the RSDetection output |
| Radiation source and holder | Cs137 or Co60 |
| Lead bricks | Radiation shield |
| Work area | Approximately 25' by 6'.<br>Should allow enough room to keep the HPIC at least 5' from the wall to reduce reflected radiation effects. |
| Tripod | Adjustable height of at least 60" (1.5 m) |
| Plumb line | |
| Cable | Network connection or USB cable connected to host computer |

1. Attach the unit to the tripod.
2. Adjust the tripod height to approximately 60" (1.5m) from the floor to the center of the chamber.
3. Hang the plumb line from a point under the unit's chamber housing on the chamber centerline to the floor. The below figure illustrates how to determine the chamber's center on the bottom of the housing.

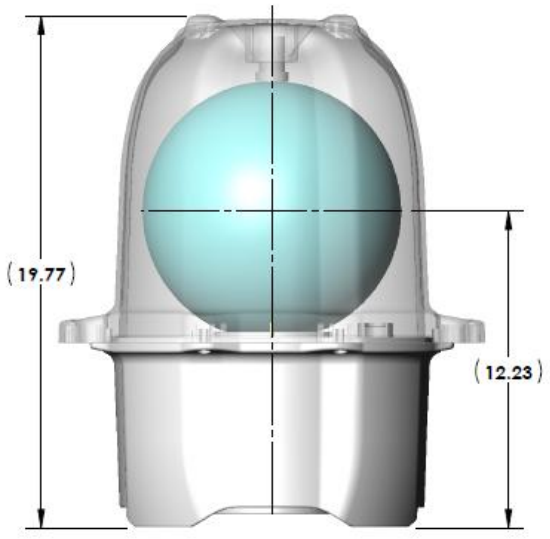


Figure 28 RSDetection Side View Dimensions Relative to Center of Ion Chamber (inches)

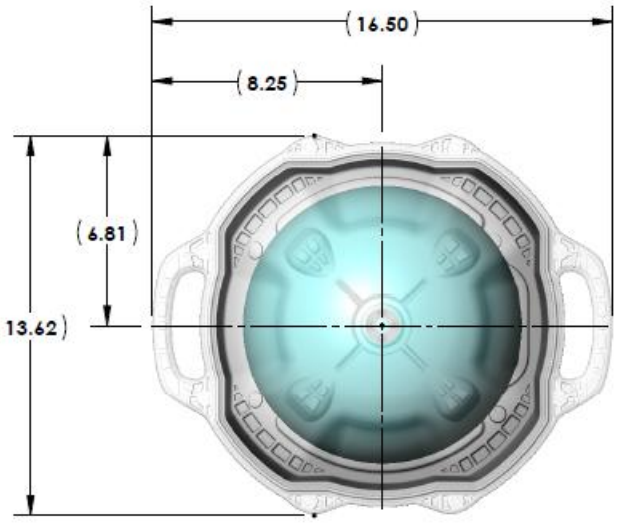


Figure 29 RS Detection Top View Dimensions Relative to Center of Ion Chamber (inches)

4. Start from the plumb line and measure in a direct line the following increments for the value of "D":
    - 12'
    - 14'
    - 16'
    - 18'
5. Attach the RSDetection to the network or connect a USB cable between the PC and the units USB (B) connector.
6. Set the radiation source at the 10' mark at a height equal to the chamber centerline. Refer to Figure 30 for setup.

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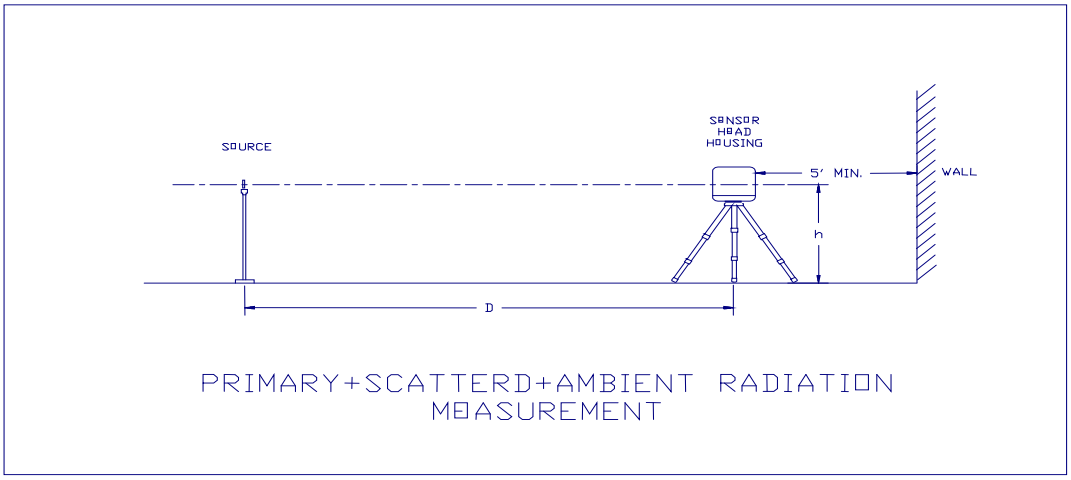


Figure 30 Calibration Setup with No Shield

## 6.3 Sensor Sensitivity Measurement

After completing the equipment setup, complete the following steps to record the sensor sensitivity at various increments.

THE RADIATION SOURCE SHOULD BE AT THE 10' MARK WHEN COMPLETING THE FIRST READING.

1. Connect power to the sensor and turn it on.
2. Remove the shield so that the source is not obstructed from the sensor. Refer to Figure 30.
3. Allow the signal to stabilize for approximately one minute and then start recording the data to the data collection system for a sufficient time period to obtain a stable reading.
4. Move the shield into place between the source and the HPIC. Refer to Figure 31.

THE SHIELD CENTERLINE MUST BE INLINE WITH THE CHAMBER CENTERLINE TO THE SOURCE. THE SHIELD MUST BE PLACED BETWEEN THE SOURCE AND THE SENSOR SO THAT IT COMPLETELY SHIELDS THE DETECTOR FROM THE SOURCE.

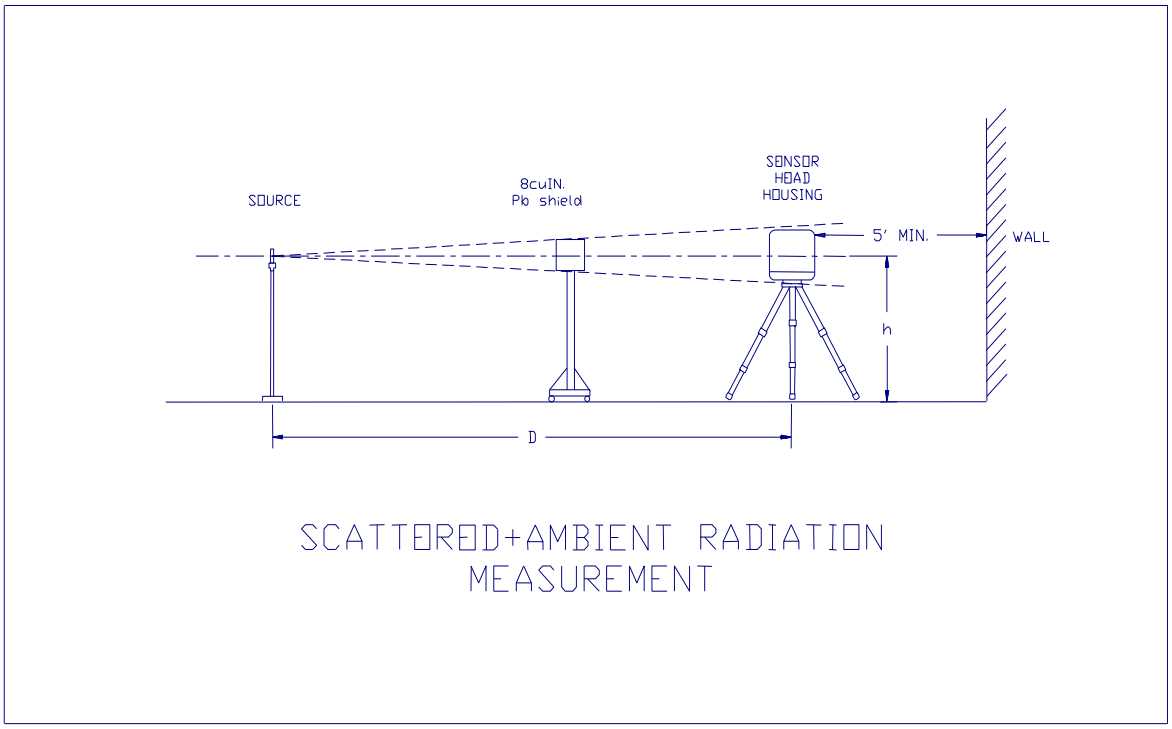


Figure 31 Calibration Setup with Shield

5. Allow the reading to stabilize and then record to the data collection system for a time period sufficient to obtain a stable reading.
6. Repeat steps 1 through 6 for each value of "D" (12', 14', 16', and 18').

## 6.4 Calculating Sensitivity

Table 17 explains how to calculate the sensor sensitivity using the Calibration Data sheet. A sample Calibration Data sheet is provided in Figure 32.

Table 17 Senor Sensitivity Calculation

| | |
|---|---|
| P+S+A | **Primary + Scattered + Ambient** is the reading in amps (NO shield between the source and the chamber. |
| S+A | **Scattered + Ambient** is the reading in amps taken with the shield in place. |
| P | **Primary** is the difference of the readings:<br>**amps(P) = amps (P+S+A) – amps (S+A)** |
| Exposure rate | Determined for each distance involved from the exposure rate at one meter from the source. |

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| | |
|---|---|
| Source calibration | Indicates the **exposure rate at one meter on a specific date**. This exposure rate must be corrected for the decay of the source from date of certification to the date of the calibration run as follows:<br>$K_d$ = e-0.693(t/T)<br>where $K_d$ = the coefficient of decay<br>**e** = natural logarithm base<br>**t** = time between the date of source certification and calibration<br>**T** = the half-life of the source (5.26 years for $Co^{60}$)<br>The values of **t** and **T** must both be expressed in the same unit of time, such as days or years. |
| $E = E_{100} * (\frac{100}{D})^2 * e^{-\mu(D-100)} * Kd$ | $E_{100}$ = exposure rate produced by gamma source at a distance of one meter as indicated on the source certificate<br>**μ** = the linear attenuation factor for air ($6.8 \times 10^{-5} cm^{-1}$)<br>**D** = distance in cm between the center of the source and center of the ion chamber<br>$K_d$ = the decay coefficient calculated for the source calibration |
| k($Co^{60}$ or Cs137) | The **value of amps (P) divided by the Exposure Rate** for the source-to-ion-chamber distance being used. Units will be amps/R/hr. |
| $\bar{k}$ | The average value of k. |
| σ | The standard deviation<br>$\sqrt{\frac{\sum k_i^2 - n\bar{k}^2}{n-1}}$<br>*OR*<br>$\sqrt{\frac{n\sum k_i^2 - (\sum k_i)^2}{n(n-1)}}$<br>where **n** = number of measurements of k, typically 4. |
| V = σ/k | Should be **less than 1%**. If it is not, the readings show too much variation, and they may not be valid. Repeat the readings carefully. |
| $\bar{k}$ ($Ra^{226}$) | The **average value of k corrected for the radiation energy spectrum of $Ra^{226}$** by the relation:<br>$\bar{k}$ ( Ra226) = (0.91) x $\bar{k}$ ($Cs^{137}$) or (1.022) x $\bar{k}$ ($Co^{60}$) |
| HPIC Sensitivity | $\bar{k}$ (amps/R/hr) |

### 6.4.1 Sample Calculation

1. Calculate the Exposure Rate at a distance "D" from $Co^{60}$ source 't" years after source certification:

$$D = 12\ feet(365.8cm)$$
$$t = 3.37years(1230.8days)$$
$$T = 5.26years(1920days)$$
$$E_{100} = 1062\,uR/h$$
$$E_{12} = E_{100} * \left(\frac{100}{D}\right)^2 * e^{\mu(D-100)} * K_d$$
$$E_{12} = 1062uR/h\left(\frac{100}{365.8}\right)^2 * e^{-6.8E-5(265.8)} * e^{-0.693(3.5/5.26)}$$
$$E_{12} = 1062uR/h * 0.07475 * 0.982 * 0.63$$
$$E_{12} = 49.1uR/h$$

4. Sensitivity of the sensor at distance "D" from $Co^{60}$ source:

| D | | EXPOSURE RATE | P+S+A | S+A | P | k(Co60) |
|---|---|---|---|---|---|---|
| Feet | cm | R/h | amps | amps | amps | amps/R/h |
| 12 | 365.8 | 202.8e-6 | -6.124e-12 | -1.403e-12 | -4.722e-12 | -2.328e-8 |

K = [(P+S+A) – (S+A)] / Exposure Rate

k = [-6.124e-12 – -1.403e-12 ] / 202.8e-6 R/h

k = -2.328e-8 amps/R/h

5. Calculate the average sensitivity. In a typical calibration, the following values of k might be calculated:

| D | | k |
|---|---|---|
| Feet | cm | amps/R/h |
| 12 | 366 | -2.328e-8 |
| 14 | 427 | -2.335e-8 |
| 16 | 488 | -2.336e-8 |
| 18 | 549 | -2.333e-8 |
| | Average($\bar{k}$) | -2.333e-8 |

6. Calculate the standard deviation σ = 3.6e-11.

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7. Calculate the coefficient of variation of individual readings:

   V = σ / k

   V = 3.6e-11 / -2.333e-8

   V = 0.154%

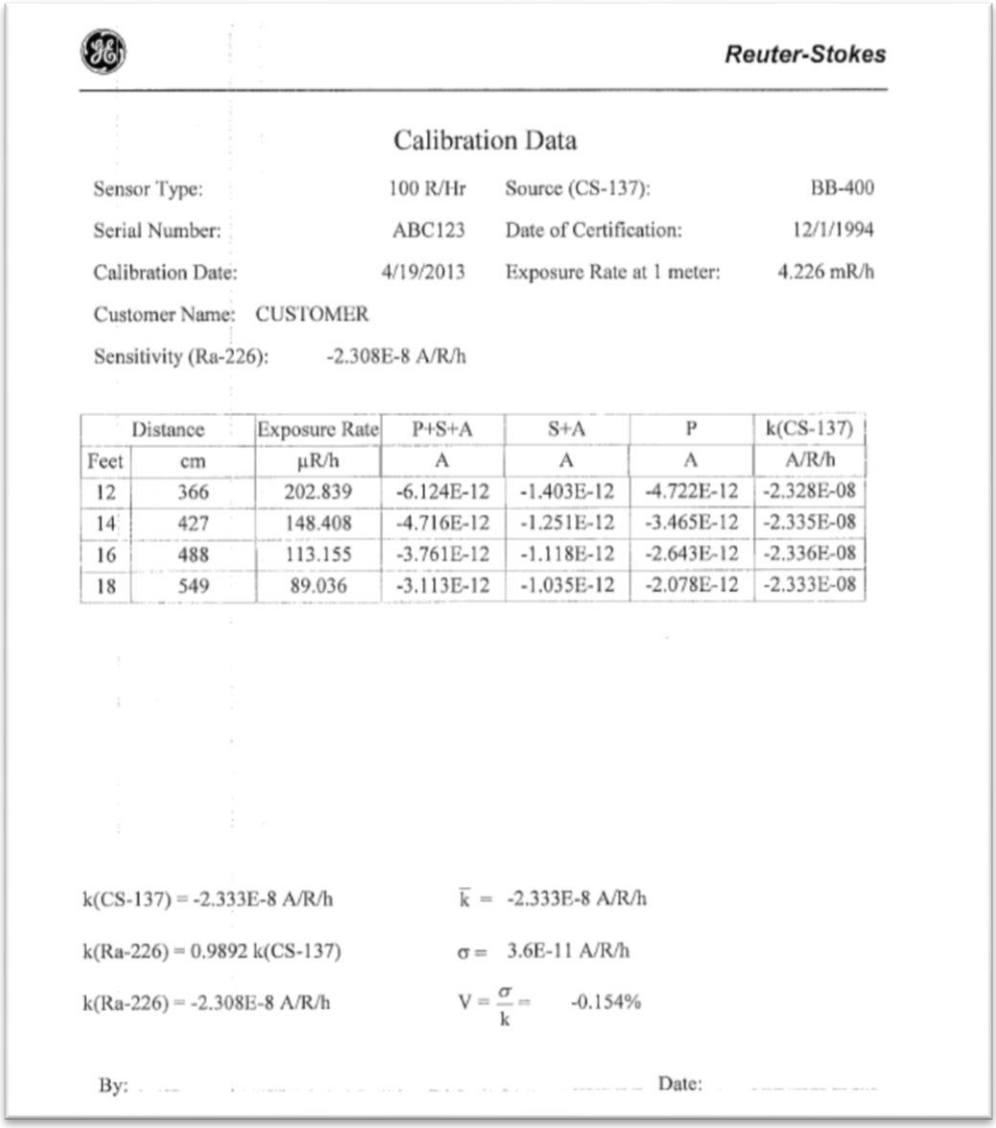
   V = 0.154% is less than 1% and indicates acceptable data.

8. Correct k($Co^{60}$) to k($Ra^{226}$):

   $\bar{k}$ (Ra226) = 0.989 * $\bar{k}$ (Cs137)

   $\bar{k}$ (Ra226) = 0.989 x -2.333e-8 amps/R/h

   $\bar{k}$ (Ra226) =2.308e-8 amps/R/h



Reuter-Stokes

Calibration Data

| | | | |
|---|---|---|---|
| Sensor Type: | 100 R/Hr | Source (CS-137): | BB-400 |
| Serial Number: | ABC123 | Date of Certification: | 12/1/1994 |
| Calibration Date: | 4/19/2013 | Exposure Rate at 1 meter: | 4.226 mR/h |

Customer Name: CUSTOMER

Sensitivity (Ra-226): -2.308E-8 A/R/h

| Distance | | Exposure Rate | P+S+A | S+A | P | k(CS-137) |
|---|---|---|---|---|---|---|
| Feet | cm | µR/h | A | A | A | A/R/h |
| 12 | 366 | 202.839 | -6.124E-12 | -1.403E-12 | -4.722E-12 | -2.328E-08 |
| 14 | 427 | 148.408 | -4.716E-12 | -1.251E-12 | -3.465E-12 | -2.335E-08 |
| 16 | 488 | 113.155 | -3.761E-12 | -1.118E-12 | -2.643E-12 | -2.336E-08 |
| 18 | 549 | 89.036 | -3.113E-12 | -1.035E-12 | -2.078E-12 | -2.333E-08 |

k(CS-137) = -2.333E-8 A/R/h

k(Ra-226) = 0.9892 k(CS-137)

k(Ra-226) = -2.308E-8 A/R/h

$\bar{k}$ = -2.333E-8 A/R/h

$\sigma$ = 3.6E-11 A/R/h

$V = \frac{\sigma}{k}$ = -0.154%

By: Date:

Figure 32 Sample Calibration Data Sheet

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# 7 XML COMMANDS

## 7.1 OVERVIEW

Extensible Markup Language (XML) is a text-based format that allows for representation of arbitrary data structures. This flexibility allows for a wide range of commands and responses between a computer and the RSDetection unit.

A description of these commands is beyond the scope of the user manual are located in a separate manual titled RSDetection Communication Manual.

# 8 APPENDIX

## 8.1 CONFIGURATION UTILITY INSTALLATION

The installation consists of two files, setup.exe and RSDetectionSetup.msi. Both must be present in the install folder before running the installation. In some cases it may be necessary to also update the unit firmware. In this case ensure that the new firmware is loaded before installing the configuration utility. Refer to the Main Menu Functions section for details on loading firmware.

WHEN VIEWING THE INSTALL FILES IN WINDOWS EXPLORER THE FILE EXTENSIONS ".EXE" AND ".MSI" MAY NOT BE VISIBLE IF "HIDE EXTENSIONS FOR KNOWN FILE TYPES" IS CHECKED.

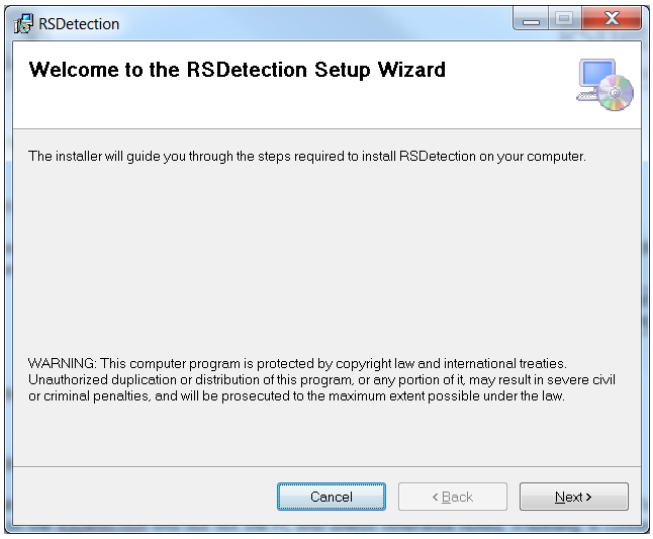
RSDetection
Welcome to the RSDetection Setup Wizard
The installer will guide you through the steps required to install RSDetection on your computer.
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.
Cancel
< Back
Next >

Figure 33 RSDetection Setup

1. Install the "Software/Manual CD" part number RS-S131-200-CD into the computer
2. Run the setup.exe application and the following dialog will be displayed.

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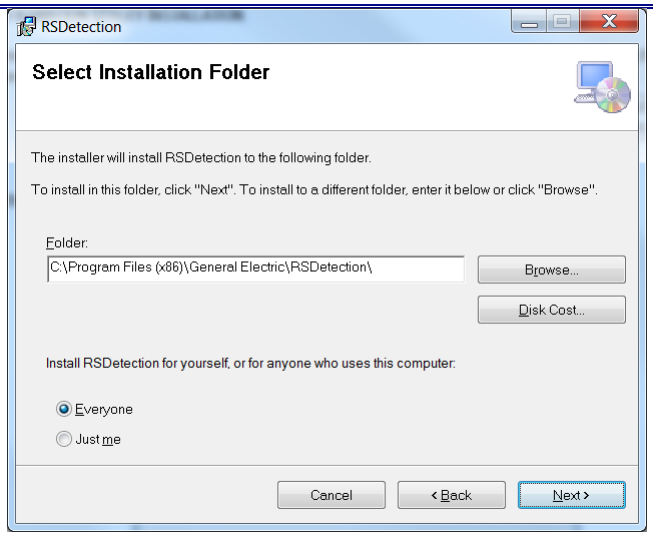
RSDetection
Select Installation Folder
The installer will install RSDetection to the following folder.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:\Program Files (x86)\General Electric\RSDetection\
Browse...
Disk Cost...
Install RSDetection for yourself, or for anyone who uses this computer:
Everyone
Just me
Cancel
< Back
Next >

Figure 34 Installation Dialog

3. Click **Next** and an installation folder dialog appears as shown below.
4. Type the folder name to the desired installation folder or leave the folder at the default location and click on **Next**.
5. A progress window displays followed by a message that the installation was successful.
6. Click **Close** to complete the installation. A shortcut will appear on the desktop.

Follow these steps to determine if an update to the Configuration Utility is required:

1. Run the Configuration Utility.
2. Locate the current Configuration Utility version by selecting Help and then About. If the new version is greater than the current version, updating is required.

## 8.2 External Connector Pinouts

All external connections must be made using weatherproof components. Cables listed in the following tables are rated to IP67 on the RSDetection end, but not the PC end, unless otherwise noted.

If nothing is connected to any of the connections, the weatherproof covers provided with the unit must be secured on the connector. Failure to do so will violate the IP rating of the device and possibly allow moisture into the unit.

### 8.2.1 Power

The RSDetection power connector is a Samtec IPL1-104-01-L-S-K, 4-pin connector. Table 18 provides the pin number, description, and voltage. It is the customer's responsibility to provide power using appropriate weatherproof connections. GE offers a blunt cut power cable, P/N RS-S131-200-PWRCAB.

The power connector is intended for connection to a customer-provided power supply. This may be a dedicated supply, solar panel with battery, or other power source. The external power requirement is 11-15VDC and 30W max.

The DC power supply provided with the unit is NOT weatherproof and must be placed in an approved weatherproof enclosure if it is to be used outside.

Table 18 Power Connector Pinout

| Pin # | Description | Direction | Voltage / Drive Specs |
|---|---|---|---|
| 1 | GND | GND | Ground |
| 2 | GND | GND | Ground |
| 3 | DCIN | PWR | 12 VDC |
| 4 | DCIN | PWR | 12 VDC |

### 8.2.2 Dedicated Serial Connection

A 10 pin Samtec connector (IPL-1-105-01-L-D-K) provides two dedicated serial ports (referred to as A and B). Port A is reserved for factory debugging, and Port B is available for customer use. See Table 19 for the serial connector pin outs. GE offers mating cables, P/N RS-S131-200-232 and RS-S131-200-232-AD.

The dedicated serial port is intended to connect to a PC running the Configuration Utility, terminal program, or other customer-provided software.

Table 19 10 Pin Serial Connector Pinouts

| Pin # | Description | Direction | Voltage / Drive Specs |
|---|---|---|---|
| 1 | Port B GND | GND | Ground |
| 2 | Port B RxD | Into unit | RS-232 levels |
| 3 | Port B TxD | Out of unit | RS-232 levels |
| 4 | Port B CTS | Into unit | RS-232 levels |
| 5 | Port B RTS | Out of unit | RS-232 levels |
| 6 | Port A GND (Factory use only) | GND | Ground |
| 7 | Port A RxD (Factory use only) | Into unit | RS-232 levels |
| 8 | Port A TxD (Factory use only) | Out of unit | RS-232 levels |
| 9 | Port A CTS (Factory use only) | Into of unit | RS-232 levels |
| 10 | Port A RTS (Factory use only) | Out unit | RS-232 levels |

### 8.2.3 USB Type B

This is a standard full-size Type B connector. This port is intended for connection only to a PC running the Configuration Utility or other similar customer-provided software.

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#### 8.2.4 USB Type A (2)

There are 2 full-size USB Type A connectors. These ports are intended to connect to USB hubs or USB-to-serial adapters that utilize the factory specified FTDI converter chips.

#### 8.2.5 Ethernet

This is a standard RJ-45 connector. The Ethernet port is intended to connect to a standard Ethernet device, such as a router or switch, depending on the customer network.

FOR OUTDOOR OPERATION, THE FACTORY RECOMMENDED CABLES MUST BE USED TO ENSURE AN IP66 SEAL. IF THE PORT IS NOT USED, THE PROVIDED CONNECTOR COVER MUST BE INSTALLED.

## 8.3 Supported External Devices

The following external devices are supported by the RSDetection:

- Vaisala Meteorological Station (P/N WXT520)
- FTDI USB to serial adapters (US232R-xx)

Support for additional devices may be requested by customers, but cannot be guaranteed.

## 8.4 System and Accessory Part Numbers

Table 20 System and Accessory Part Numbers

| Systems | Description |
|---|---|
| RS-S131-200-ER0000 | Environmental Gamma Radiation Monitor without internal battery |
| RS-S131-200-ERB000 | Environmental Gamma Radiation Monitor with internal battery |
| **Power Supply/Cordsets (For Indoor Use Only)** | |
| RS-S131-200-PWRCAB | Power Cable, 3M, Blunt cut (use with customer power supply) |
| RS-S131-200-PWR | 12V Universal power supply w/ Adapter cable |
| RS-S131-200-PC-01 | Cord set for 12V power supply, North American |
| RS-S131-200-PC-02 | Cord set for 12V power supply, Euro |
| RS-S131-200-PC-03 | Cord set for 12V power supply, Australia |
| RS-S131-200-PC-04 | Cord set for 12V power supply, Britain |
| RS-S131-200-PC-05 | Cord set for 12V power supply, Japan |
| RS-S131-200-PC-06 | Cord set for 12V power supply, Russia |
| RS-S131-200-PC-07 | Cord set for 12V power supply, China |
| RS-S131-200-PC-08 | Cord set for 12V power supply, Brazil |
| **External Cables (IP67 on RSDetection end)** | |
| RS-S131-200-EN | Ethernet cable (IP67 on RSDetection end) |
| RS-S131-200-USBA | USBA cable (IP67 on RSDetection end) |
| RS-S131-200-USBB | USBB cable (IP67 on RSDetection end) |
| RS-S131-200-232 | RS-232 cable (10 pin circular to DB9 socket) |
| RS-S131-200-232-AD | RS-232 to RSS-131 serial adapter cable (10 pin circular to RSS-131 Switchcraft connector). This is only required to place an RSDetection in service where older RSS131 cabling is present (S131-232-002). |
| **Miscellaneous** | |
| RS-S131-200-KIT | Quick start Manual, Ethernet and USBB cables w/ dust cover, Power supply and Adapter, CD - Software and Manuals |
| RS-S131-200-BATT | 7.2V Li-Ion battery |
| RS-S131-200-BCOV-K | Battery cover assembly (includes cover and gasket) |
| RS-S131-200-DAQ | DAQ board assembly, with bracket |
| RS-S131-200-DC-KIT | Dust cover kit (includes covers for external connectors) |
| RS-S131-200-ELEC-K | Electrometer assembly, with hardware |

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| | |
|---|---|
| RS-S131-200-G-KIT | Gasket kit (includes case gasket and battery cover gasket) |
| RS-S131-200-S-KIT | Gasket kit, HPIC support |
| RS-S131-200-CD | Manuals, Configuration Utility, Firmware |

## 8.5 LEGACY SOFTWARE CONFIGURATION

RSDetection supports a subset of the serial commands used on the older units. This section describes the supported and unsupported commands.

THIS MODE OF OPERATION IS NOT RECOMMENDED FOR NEW SYSTEMS MADE ENTIRELY OF RSDETECTION. IT SHOULD BE USED ONLY ON EXISTING SYSTEMS WHICH INCLUDE BOTH RSDETECTION AND OLDER UNITS WHERE EXISTING CENTRAL COLLECTION SOFTWARE IS ALREADY IN PLACE USING OLDER COMMANDS.

### 8.5.1 Legacy Command Support

Table 21 though Table 30 list commands from legacy units and specify those that are supported and those that are not supported for the RSDetection firmware. Commands are listed by category.

### 8.5.2 "D", "L" and "E" Commands

Table 21 "D", "L", and "E" Command Support

| Command | Support | Comments |
|---|---|---|
| D | Yes | Computes the average dose rate since the last "D" command was received.<br>Command<br>#D0<CR><br>Response<br>D Y 0 SSSS HHHH BB.BB AAAAA EEEE CC<CR><LF><br>Y – Unit address<br>SSSS - CPU STATUS: 0 = OK 1 = ERROR,<br>A/D STATUS: 0 = OK 1 = ERROR<br>BATTERY STATUS: 0 = OK 1 = LOW (<6.0 V),<br>ALARM FLAG: 0 = NO ALARM 1 = ALARM.<br>HHHH – High voltage<br>BB.BB – Battery voltage<br>AAAAA – Dose rate in mR/h<br>EEEE – Minutes unit has been averaging<br>CC – Sum of digits not including the "D" or Check Sum Itself |

| Command | Support | Comments |
|---|---|---|
| E | Yes | Same as 'D' command except the averaging buffer is not reset.<br>Command<br>#E0<CR><br>Response<br>E Y 0 SSSS HHHH BB.BB AAAAA EEEE CC<CR><LF> |
| L | Yes | Retransmits the last "D" response, with an "L" instead of "D".<br>Command<br>#L0<CR><br>Response<br>L Y 0 SSSS HHHH BB.BB AAAAA EEEE CC<CR><LF> |

### 8.5.3 "M" Commands

Table 22 "M" Command Support

| Command | Support | Comments |
|---|---|---|
| M0 | Yes | Transmits the entire data buffer (maximum 500 points) to the interrogating device. An example of the first few lines is below.<br>The first line indicates the number of points followed be recoding interval in seconds. The remained values corresponds to the 'D' command response<br>Command<br>#M00<CR><br>Response<br>00125 00015 0000 0000 06.80 00.00 00.00 00028<CR><br>.0125 .0122 .0136 .0142 .0137 .0129 .0130 .0131 .0131 .0127 00077<CR><br>.0127 .0126 .0132 .0131 .0140 .0135 .0130 .0122 .0122 .0127 00068<CR><br>.... |
| M1 | Yes | Resets the data buffer<br>Command<br>#M01<CR><br>Response<br>M01<CR><LF> |

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### 8.5.4 "A" Commands

Table 23 "A" Command Support

| Command | Support | Comments |
|---|---|---|
| A4 | Yes | Sets the recoding interval for the M command<br>AY4XXXXX<CR><LF><br>Y – Unit address<br>XXXXX – Storage interval. Valid values are:<br>**5, 10, 15, 30, 60, 120, 300, 600, 900** |
| A6 | No | Reset Unit |
| A7 | No | Set phone number |

### 8.5.5 "P" Commands – Configuration Commands

Since all of the 'P' commands follow the same format, the format for each command will not be described in the table. The command format is as follows.

#P Y PPP DDDD<CR>

Y – Unit address

PPP – Configuration parameter shown in Table 24.

DDDD – A variable length field used when setting the parameter value.

The database is used in the RSDetection system to store data, and the configuration parameters described in the XML command section should be the preferred method of configuration. These P commands are provided for legacy command support.

Table 24 "P" Command Support

| Parameter | Support | Comments |
|---|---|---|
| Wind Speed | | |
| SPT | No | Number of points in the queue. Always returns 20000 |
| SPI | Yes | Seconds between logging. |
| SAL | No | High alarm level. Returns 00000 |
| SAH | No | Low alarm level. Returns 00000 |
| SPC | No | Returns 0.1 |
| Wind Direction | | |
| DPT | No | Number of points in the queue. Always returns 20000 |
| DPI | Yes | Seconds between logging. |
| DAL | No | High alarm level. Returns 00000 |
| DAH | No | Low alarm level. Returns 00000 |
| Air Pressure | | |

| Parameter | Support | Comments |
|---|---|---|
| PPT | No | Number of points in the queue. Always returns 20000 |
| PPI | Yes | Seconds between logging. |
| PAL | No | High alarm level. Returns 00000 |
| PAH | No | Low alarm level. Returns 00000 |
| Bias Voltage | | |
| VPT | No | Number of points in the queue. Always returns 20000 |
| VPI | Yes | Seconds between logging. |
| VAL | No | High alarm level. Returns 00000 |
| VAH | No | Low alarm level. Returns 00000 |
| Battery Voltage | | |
| BPT | No | Number of points in the queue. Always returns 20000 |
| BPI | Yes | Seconds between logging. |
| BAL | No | High alarm level. Returns 00000 |
| BAH | No | Low alarm level. Returns 00000 |
| Temperature | | |
| TPT | No | Number of points in the queue. Always returns 20000 |
| TPI | Yes | Seconds between logging. |
| TAL | No | High alarm level. Returns 00000 |
| TAH | No | Low alarm level. Returns 00000 |
| Dose Rate | | |
| HPT | No | Number of points in the queue. Always returns 20000 |
| HPI | Yes | Seconds between logging. |
| HAL | No | High alarm level. Returns 00000 |
| HAH | No | Low alarm level. Returns 00000 |
| RAI | Yes | Smoothing time constant Valid values are 0,1,2 or3 |
| RAC | Yes | HPIC calibration value in amps/R/h. Nominal value = 2.3e-8 |
| Electrometer Zero | | |
| ZLN | No | Returns 0. |
| ZMN | No | Returns 0. |
| ZHN | No | Returns 0. |
| ZLD | No | Returns 0. |

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| Parameter | Support | Comments |
|---|---|---|
| ZMD | No | Returns 0. |
| ZHD | No | Returns 0. |
| Electrometer Gain | | |
| RLN | No | Returns 0. |
| RMN | No | Returns 0. |
| RHN | No | Returns 0. |
| RLV | No | Returns 0. |
| RMV | No | Returns 0. |
| RHV | No | Returns 0. |
| General | | |
| UID | Yes | Sets or returns the unit address 0-Z except '@'. |
| HEU | Yes | Sets or returns the R to Sv conversion factor.. |
| DTF | Yes | Legacy date format 0 = mm/dd/yy, 1=dd/mm/yy. |
| WDE | No | Watchdog enable. Returns 1. |
| COM1 | | |
| C1B | No | |
| COM2 | | |
| C2B | Yes | Sets or returns the RS=232 port baud rate. Valid values are: 300,600,1200,2400,9600,19200. |
| C2P | Yes | Parity for the RS-232 port. Valid values are: (E, O, N) |
| C2H | Yes | Handshaking for the RS-232 port. Valid values are: 0 = No handshake, 1=RTS/CTS, > 1 delay in mSec. |
| COM3 | | |
| C3B | No | |
| C3P | No | |
| C3H | No | |
| COM4 | | |
| C4B | No | |
| C4P | No | |
| C4H | No | |
| Alarm Dial | | |
| ADN | No | |

| Parameter | Support | Comments |
|---|---|---|
| External Serial Display | | |
| XDP | Yes | Set returns the serial port used by the display.<br>0 = No display, 1 = COM1, 2 – COM2, 4 = COM4. |
| XDU | Yes | External display units 0 = R/h, 1 = Sv/h. |

### 8.5.6 "C"" Commands – Clear Data Queue

Table 25 "C" Command Support

| Command | Support | Comments |
|---|---|---|
| C | No | This command is intended to clear the data queues for the various sensors. Since the data is kept in the database these commands are not supported.<br>The command format is<br>#C Y X<CR><br>Y – Unit address<br>X – Data type |

### 8.5.7 'Q" Commands – Display Data Queue

Table 26 "Q" Command Support

| Command | Support | Comments |
|---|---|---|
| Q | Yes | This command will display all queue data for the specified device between the specified start and end dates. If the start date is specified with no start time and no end date/time, all data points from midnight of the start date until the current time will be retrieved. If start date and time are both specified, but no '-' and no end date/time, all data points from the specified start time until the current time will be retrieved. If neither start nor end times are specified all data points in the queue will be displayed.<br>If an end date (**eeee** below) is specified both the start date and start time must be specified. If an end date is specified, however, the end time may be omitted. In this case the end time will be midnight of the specified end date.<br>Values entered are not required to be exactly two digits. For example, February 7, 1998 could be entered as any of the following strings: 02/07/98, 2/7/98, 02/7/98, 2/07/98, 02/07/1998, 2/7/1998, 02/7/1998 or 2/07/1998<br><br>Command<br>Command |

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| Command | Support | Comments |
|---|---|---|
| | | #Q Y N SSSS TTTT – EEEE UUU<CR><br>Y – Unit address<br>N – The ID of the sensor as outlined below.<br>SSSS– Start date.<br>TTTT– Start Time.<br>EEEE– End date.<br>UUUU– End Time.<br>**Sample Output**<br>Note that it is assumed each point has been recorded at the time interval indicated by the first returned line. If a gap is detected a new time stamp will be generated.<br>00:00:08 //;8 seconds between points<br>05/29/98 14:22:33 //Time stamp<br>.0079 .0068 .0078 .0079 .0077 .0084 .0074 .0083 .0076 .0070 00129<br>.0075 .0077 .0074 .0079 .0078 .0072 .0076 .0080 .0073 .0073 00118<br>.0073 .0079 .0074 .0070 .0073 .0071 .0084 .0083 00085<br>05/29/98 14:28:50 // Time stamp after gap<br>.0066 .0078 .0077 .0087 .0082 .0073 .0078 .0067 .0076 .0068 00131<br>.0069 .0074 .0080 .0070 .0079 .0079 .0077 .0076 .0075 .0069 00127<br>.0080 .0075 .0079 .0078 .0082 .0070 .0081 .0079 .0071 .0074 00112<br>.0076 .0080 .0075 00033 |

### 8.5.8 "S" Commands – Display Sensor Data

Table 27 'S' Command Support

| Command | Support | Comments |
|---|---|---|
| S | Yes | This command will display the current calculated value once per second for all sensors followed by a <CR>. The data sent will be the instantaneous value for each sensor after going through the appropriate conversions. These are the values that are summed together and divided by the recording interval to obtain the value that is written to the queue. Data will continue to be displayed until any character is received at the COM port. The order of sensors in the line is:<br>• Wind Speed (*)<br>• Barometric Pressure (psia)<br>• Wind Direction (°)<br>• Dose rate (mR/h)<br>• High Voltage (V)<br>• Battery Voltage (V)<br>• Temperature (°C)<br>#SY<CR><br>Y – Unit address<br>Response<br><CR><br>.0000 .0000 .0000 .0000 .0085 547.8 5.688 22.40 .0000<br>.0000 .0000 .0000 .0000 .0082 547.3 5.684 22.40 .0000<br>.0000 .0000 .0000 .0000 .0086 547.3 5.682 22.40 .0000 |

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### 8.5.9 "T" Commands – Set Date and Time

Table 28 'T' Command Support

| Command | Support | Comments |
|---|---|---|
| T | Yes | This command allows the user to set or view the time and date. If all parameters are specified the time and date are set to the values on the command line. If only the first two parameters are specified the user will see the current time and date values displayed.<br>Command<br>#T Y DDDD TTTT<CR><br>Y – Unit address<br>DDDD – date<br>TTTT – Time<br>Response<br><CR><br>03/25/97 02:24:35 |

### 8.5.10 "U" Commands – Uptime

Table 29 "U" Command Support

| Command | Support | Comments |
|---|---|---|
| U | Yes | Returns the number of minutes the unit has been operating.<br>Command<br>#U Y<CR><br>Y – Unit address<br>Response<br><CR><br>Uptime: 3 Days 6 Hrs 4 Mins |

### 8.5.11 "V" Commands – Version

Table 30 "V" Command Support

| Command | Support | Comments |
|---|---|---|
| V | Yes | Returns the firmware version and IP address.<br>Command<br>#V Y<CR><br>Y – Unit address<br>Response<br><CR><br>RSDetection Version 2.2 IP=192.1698.0.102 |

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## 8.6 CUSTOMER SUPPORT CENTERS

**For Sales, Service and Technical Support:**

GE Measurement and Sensing

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Twinsburg, Ohio 44087

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